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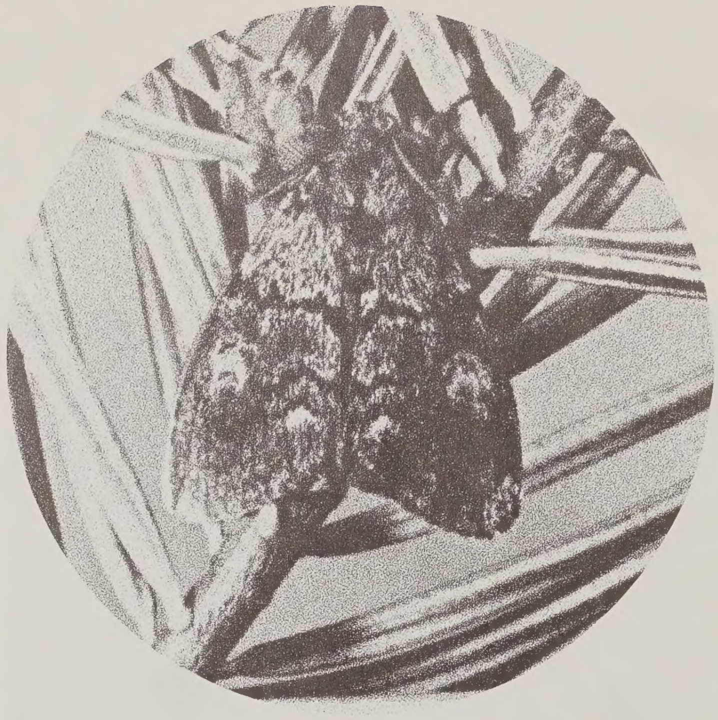

1974 COOPERATIVE DOUGLAS-FIR TUSSOCK MOTH CONTROL PROJECT

OREGON • WASHINGTON • IDAHO

by
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FOREST SERVICE • USDA
PACIFIC NORTHWEST REGION

PORTLAND, OREGON • JULY, 1975

1—Devastation to timber resource in eastern Oregon from tussock moth.

2—Timbered area protected from major impact of tussock moth by use of DDT insecticide.

Abstract

On June 9, 1974, spraying began on the largest and most controversial all-helicopter aerial forest insect control project ever carried out in the Pacific Northwest. This control project clearly demonstrated the need for a united and cooperative approach by State and Federal agencies and private timber owners in order to effectively combat outbreaks of indiscriminating forest pests.

When spraying was completed on July 25, 1974, 426,559 acres of tussock moth-infested forest lands in the States of Oregon, Washington, and Idaho had been treated. Of this total, 420,944 acres were treated with DDT at a rate of 3/4 pounds per gallon of fuel oil carrier per acre. The remaining 5,615 treated acres were treated with DDT at rates of 1/4 and 1/2 pound per acre. Additional acres were treated with Dylox, Sevin-4-Oil, a number of other insecticides, and microbials in a number of field tests and pilot projects. Separate reports are being prepared for these tests.

Extensive damage on about 800,000 acres occurred within 3 years after these outbreaks began. By the end of 1973, tussock moth feeding had caused heavy damage with concentrated tree mortality on about 89,000 acres and approximately 292,000 acres of moderate damage with scattered tree killing and some concentrated top-killing. In addition, nearly 419,000 acres of Douglas-fir and true fir type sustained light damage with scattered tree mortality and scattered top-killing.

In the fall of 1973, an egg mass survey indicated that populations would be high enough in 1974 to cause extensive additional tree mortality, top-kill, and general defoliation on about 649,000 acres. Continuing evaluations during the winter and early spring months reduced the area proposed for treatment to about 455,000 acres. Reductions in acreage planned for treatment resulted from acres set aside for testing other chemical and microbial control agents, and natural reductions of insect populations in some areas. Some increases in treated areas occurred due to additional infested areas discovered by ground and aerial surveys during the summer. These off-setting factors resulted in a net reduction in acreage treated from the original 455,000 acres planned.

DDT was the only chemical which had previously been proven to be effective in controlling the Douglas-fir tussock moth. Many other chemicals including Dylox[R], Sevin-4-Oil[R], Zectran[R], several pyrethrins and two microbial agents (*Bacillus thuringiensis* and nucleopolyhedrosis virus) had been tested previously (Mounts et.al. 1973, Markin et.al. 1973). Some of these materials were not satisfactory; others appeared promising but required additional large scale testing to establish their effectiveness under operational conditions. No other materials were registered or had been proven effective on a large-scale operational basis.

The proposed action was subjected to thorough public review through a National Environmental Policy Act environmental statement, public meetings, press conferences, and posted public notices. Most of those responding felt strongly that the treatments should be carried out.

The control project was highly successful in accomplishing its objectives. The effect of the DDT on the Douglas-fir tussock moth populations was immediate and dramatic. Postspray-weighted insect mortality averages for all control units was 98.8 percent. Analyses showed significant differences in the number of undamaged new needles between treated and untreated areas in most control units. Overall tree condition by the fall of 1974 was significantly better in the treated areas than in the untreated areas, particularly where insect populations were high.

It has been estimated that the treatment on the 420,944 acres prevented an additional loss of 411 million board feet of timber with a value of $11.6 million after subtracting salvage values. In addition, the treatment on these areas prevented a loss of $23.8 million in damage to immature trees, growth loss, reforestation expense, recreation loss, and increased fire protection costs. These estimates assume treatments prevented about 90 percent of the 1974 damage that would have otherwise occurred in the areas if they had not been treated.

Total control project costs were about $2,980,000 or $7.08 per acre. The Federal government paid for all costs on Federal lands. Costs on State and private lands were shared by State and Federal agencies and private landowners under authority of the Forest Pest

Control Act. The proportion in most cases was Federal, 50 percent; States 25 percent; and private landowners, 25 percent.

An environmental monitoring program was developed for the project to determine the biological effects (or lack of effects) of DDT on the forest ecosystem. A total of over 4,000 samples of water, air, vegetation, litter, stream sediment, benthic invertebrates, fish, birds, deer, elk, sheep, coyotes, chipmunks, mice, shrews, human blood, milk, and livestock have been collected for analysis. About 1,100 of these have been analyzed to date. The preliminary results of this monitoring indicate that there was little acute, short-term environmental damage due to the treatments. Sampling will continue on this short-term program through August 1975. Several studies will be continued for an extended period of time in order to determine if any significant long-term adverse environmental effects occurred. Final reports will be prepared as these studies are completed.

Acknowledgements

It is not possible to personally acknowledge the large numbers of people who made significant contributions to this project and report. However, the following individuals were particularly helpful in assembling data and making this report possible.

Wayne Bousfield, *Entomologist, Forest Service, R-1*

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Robert E. Dolph, *Supervisory Entomologist, Forest Service, R-6*

Tommy F. Gregg, *Forestry Technician, Forest Service, R-6*

R. Ladd Livingston, *Entomologist, Idaho Department of Lands*

Wayne Ludeman, *Forester, Idaho Department of Lands*

Roland (Dutch) Tiedeman, *Forester, Forest Service R-6*

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Contents

Background

The Douglas-fir tussock moth, *Orgyia pseudotsugata*, McDonnough, is one of the most destructive defoliators of true firs and Douglas-firs in western North America. Outbreaks of the Douglas-fir tussock moth appear to develop almost explosively, and after about 3 years they usually subside because of virus, parasitism, and/or predator attacks on the insect population. However, some outbreaks persist for 4 years or more.

Defoliation by the tussock moth reduces tree growth, kills the tops or kills complete trees depending upon the extent of defoliation. Subsequently, severely weakened trees are often attacked and killed by bark beetles. Past outbreaks have caused serious damage to stands of Douglas-fir, white fir, and grand fir, killing as much as 100 percent of the stand in some cases.

After mating with the winged male moth, the wingless adult female moth lays a single mass of eggs during late July through August. These eggs overwinter attached to the cocoon. In late spring the eggs hatch and many of the 1/8 of an inch long, hairy larvae are dispersed by the wind.

Larvae grow slowly at first, but after their fifth moult (instar), growth accelerates with proportionately greater destruction of foliage. Pupation occurs anytime from late July to the end of August. Adult moths appear in 10 to 18 days, mate, and repeat the life cycle.

Chemical control is most effective during the first five moults of the larvae. Although a collapse of the infestation caused by the natural virus may occur within one year, chemical control may be necessary to prevent severe damage to host trees. Virus-caused collapse of the insect population usually occurs during the last three instars of the larval stage or in the pupal stage. Prior to a collapse due to virus, serious tree damage can result.

The chronological sequence of this tussock moth outbreak in the Pacific Northwest was as follows:

1970-1971:

In 1970 the Douglas-fir tussock moth went through an insect "release phase" in several areas in central Washington developing to epidemic proportions in July of 1971. Aerial and ground surveys conducted in August and September 1971

Life cycle of Douglas-fir tussock moth: 3—Adult male; 4—Adult female; 5—Eggs of cocoon of female; 6—Young larvae on cocoon; 7—Full grown larvae.

Defoliation and Damage Chart			
Year	Area	Defoliated (Acres)	Heavy Damage (Acres)
1971	North Central Washington	2,400	250
1972	Blue Mountains, Oregon & Washington	197,000	15,000
1973	Idaho, Oregon, Washington	800,000	88,000

detected several moth infested areas in the Okanogan and Wenatchee Valleys (See Map 8A). Severe damage occurred in several small areas. Sub-epidemic populations of the tussock moth were also discovered on defoliator monitoring plots during 1971 on the Umatilla and Wallowa-Whitman National Forests in Oregon.

1972:

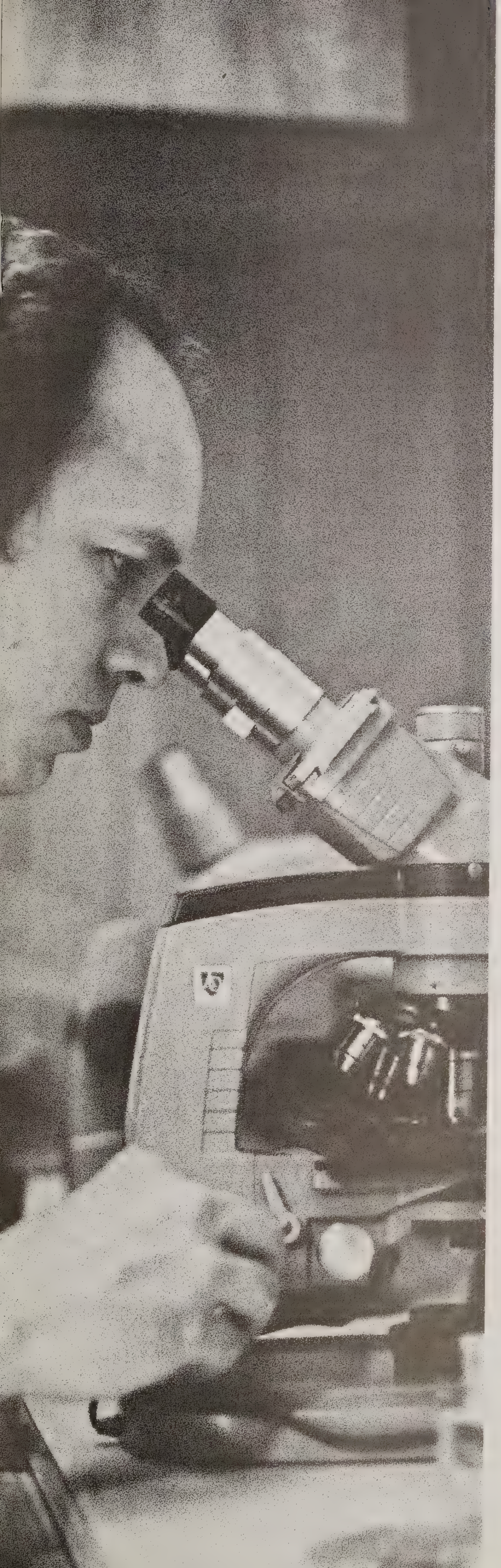
The tussock moth outbreak in the Okanogan and Wenatchee Valleys subsided by the end of the 1972 summer seasons. However, the tussock moth population in the Blue Mountains in Washington and Oregon literally exploded during late June and caused visible defoliation on about 197,000 acres (See Map 10). About 15,000 acres were heavily damaged in the La Grande, Oregon and Walla Walla, Washington areas. Substantial numbers of tussock moth egg masses were found in 1972 within a 100 acre logging unit near Charles Butte on the St. Joe National Forest, Idaho. No visible defoliation was observed in Idaho during 1972.

1973:

The tussock moth caused defoliation on some 800,000 acres of fir timber type in the States of Idaho, Oregon, and Washington (See Map 3A). A total of 36,000 unpredicated acres were discovered on the Colville Indian Reservation and 11,000 acres on lands northeast of Fairfield, Idaho. Of the grand total defoliated, about 88,000 acres were seriously damaged with large numbers of trees killed, 292,000 acres moderately damaged with scattered tree mortality and top kill, and 420,000 acres lightly damaged with scattered top kill. The total value of the merchantable timber damaged through 1973 has been calculated at $28.1 million after subtracting salvage values. An additional $30.8 million in losses occurred as a result of damage to immature trees, reduced growth loss, increased fire protection costs, and reforestation expenses.

The number of acres defoliated and heavy damage recorded between 1971 and 1973 are summarized in the defoliation and damage chart. The data are cumulative.

The outbreak history in Oregon and Washington (1971 - 1973) is shown on Maps 1 - 10, in the Appendix.



Biological Evaluation

A cooperative biological evaluation of the Oregon-Washington outbreak made by Forest Service and Oregon and Washington State forest entomologists during late 1972 and early 1973 indicated that the population was likely to increase within the areas partially defoliated in 1972 and cause considerable additional damage in 1973. The evaluation also revealed that about 449,000 acres would be defoliated in 1973 and that a considerable increase in heavily damaged areas would occur. A similar evaluation made in Idaho by Forest Service and State forest entomologists during February 1973 substantiated the potential insect buildup and indicated that at least 50,000 acres would be defoliated in that State during 1973.

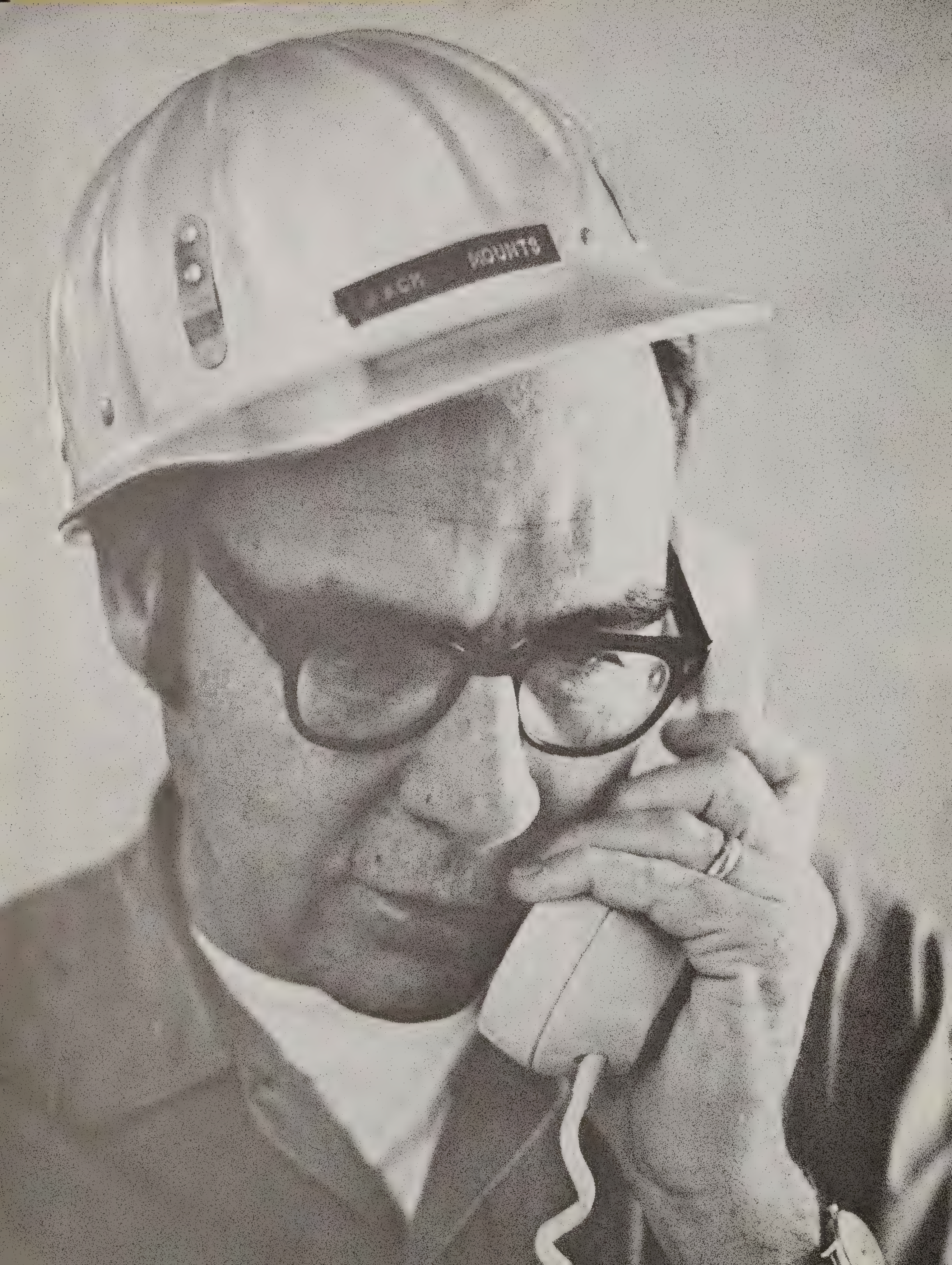
During the fall of 1973 and early in 1974 the same type of survey and evaluation with some slight procedural modifications was conducted in the three States. The objectives were to:

1. Delineate areas of the 1972-1973 infestation which had unacceptable degrees of defoliation and contained moth populations in a density capable of continuing defoliation.
2. Delineate areas outside of the 1972-1973 infestation containing egg masses capable of producing tussock moth populations which could cause unacceptable defoliation during 1974. The criteria used in the analyses were:
   a. Presence of new egg masses.
   b. Ratio of new to old egg masses.
   c. New egg mass density expressed as egg masses per thousand square inches of foliage.
   d. Incidence of natural virus present in overwintering eggs.

An egg mass threshold level of 1/10 or more egg masses per 1000 square inches of foliage was considered sufficient to cause unacceptable levels of defoliation without treatment if virus levels were low.

More than 7000 egg masses collected in the fall of 1973 throughout the outbreak area were reared in laboratories in the spring of 1974 to determine virus incidence, egg parasitism, and egg viability.

Virus treatment criteria thresholds were set at 30 or 50 percent depending on the previous defoliation history of the stand. Moderate to heavily damaged stands with a virus incidence of less than 50 percent and light to relatively unaffected stands with a virus incidence of less than 30 percent were recommended for treatment if they contained 1/10 or more egg masses per 1,000 square inches of foliage.



Events Leading To The Project

Prior to December 31, 1971, DDT was the only registered insecticide for controlling infestations of this forest pest. Several large outbreaks of the moth were controlled successfully with DDT beginning in 1947 when 413,469 acres were treated in northern Idaho, eastern Washington, and northeastern Oregon. The last previous use of DDT to control this insect was in 1965 on the Burns project in east central Oregon, the Modoc National Forest in northeast California, and the Potlatch project in northern Idaho.

In 1964 the Forest Service established an insecticide evaluation project with the primary objective of developing alternatives to the use of persistent insecticides. In 1965 tests with Dursban^R and Zectran^R were conducted without success (McComb, unpublished report). In 1972 a pilot control project was carried out to test several promising insecticides against the tussock moth as possible alternatives to DDT. These included Zectran and several pyrethrins. The results of these tests were inconclusive (PSU Forest and Range Experiment Station, unpublished data).

On June 14, 1972, the Environmental Protection Agency (EPA) issued an order, effective December 31, 1972, cancelling most uses of DDT under authority of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). On October 21, 1972, the Congress amended FIFRA when it passed the Federal Environmental Pesticide Control Act of 1972. Section 18 of the new act provides that:

> "The administrator (EPA) may at his discretion, exempt any Federal or State Agency from any provision of this Act if he determines that emergency conditions exist which require such exemption."

The Northwest Forest Pest Action Council and various State agencies began meetings in mid-year 1972 in an effort to evaluate and develop possible tussock moth control strategy. These efforts resulted in a draft Environmental Statement entitled, "USDA Forest Service Environmental Statement Cooperative Douglas-fir Tussock Moth Pest Management Plan, Oregon and Washington 1973." The statement was prepared by the Pacific Northwest Region of the Forest Service with the assistance of the States of Idaho, Oregon, and Washington, the Northwest Forest Pest Action Council, and others. The 1973 Draft Statement proposed the following:

1. Intensify salvage logging of merchantable, commercial-size timber in affected areas where serious damage has occurred.
2. Aerial spraying with the chemical Zectran on high-use and high-value recreational areas on an operational test basis.
3. Reforestation of all affected areas where necessary.

Because of possible adverse environmental effects and lack of complete information, the use of DDT was not recommended by the Forest Service at that time. The other cooperators did not agree with this approach.

On February 9, 1973, the Draft Environmental Statement was filed with the President's Council on Environmental Quality. All affected National Forests, concerned State and Federal agencies, and the general public were requested to review and comment on the Environmental Statement. Response was overwhelming with more than 2000 letters, statements, and signatures received. Over 95 percent of the responses were in favor of using DDT, if it was necessary, in order to prevent additional tree damage during 1973.

Because the mid-March results of egg viability tests indicated a low virus incidence and consequently a high probability of extensive timber damage in 1973, the Department of Agriculture filed a request on March 20, 1973, with the EPA for emergency use of DDT in 1973. The States of Oregon and Washington filed similar requests.

Upon receiving these requests an EPA team of three people from Washington, D.C. and three from Seattle, Washington, inspected some of the moth-infested areas during March 27-30. The team included William Hoffman, investigative leader; James R. Horst, economist; and Roger Pierpont, entomologist; Washington Office, and Douglas Hansen, Robert Poss and Herbert Siminson of EPA's Region 10 office. They held a series of meetings on the DDT-use request with concerned State and Federal agencies, private timber land owners, environmental groups, State legislators, and the general public at various locations in Washington and Oregon.

On April 20, 1973, the EPA denied the USDA request for emergency use of DDT to control the

tussock moth infestation. Forest Service Chief McGuire and his staff discussed the EPA's action and decided to proceed with a final Environmental Statement. On April 26, 1973, the final 1973 Environmental Statement was filed with the President's Council on Environmental Quality. This statement recommended the following:

1. Accelerated salvage of timber predicted to be damaged by the Douglas-fir tussock moth.
2. An operational test of Zectran on up to 50,000 acres.
3. Smaller-scale tests using other insecticides and microbial agents.

As proposed in the Final 1973 Environmental Statement, experimental spraying of alternate insecticides was carried out on an expanded test area over 70,000 acres in Oregon and Washington during June and July. Dylox^R, Sevin-4-Oil^R, Zectran^R, and biothanomethrin were used with Zectran being used extensively in some of the more critical areas. DDT formulations were not used. Small-scale field tests using microbial agents (*Bacillus thuringiensis* and nucleopolyhedrosis virus) were also carried out.

Much of the Zectran testing was done on private lands with the landowner paying 50 percent of the cost. Results were inconclusive and none of the tested chemicals or microbials could be recommended for general field control of the Douglas-fir tussock moth during 1974.

Without overall control the outbreak generally continued as predicted during the summer of 1973. A number of additional areas were defoliated and in some areas where only light damage was anticipated, very serious damage occurred.

The failure of the 1973 tests to yield a suitable substitute for DDT prompted reconsideration of its possible use in 1974.

The second cooperative fall egg mass survey was conducted from October 1 through November 16, 1973, to assess the potential for damage in 1974.

Results of this survey showed that populations would be high enough in 1974 to cause damage on about 649,000 acres. Since some of this acreage had been defoliated previously, it was especially vulnerable to loss from additional defoliation. The outbreak cycle had subsided in certain areas after extensive damage had occurred.

On December 3, 1973, the EPA published final regulations for Section 18 of FIFRA prescribing procedures for allowing emergency use of unregistered chemicals.

Section 166.1 of these regulations states that an emergency will be deemed to exist when:

(a) A pest outbreak has or is about to occur and no pesticide registered for the particular use, or alternative method of control, is available to eradicate or control the pest.
(b) Significant economic or health problems will occur without the use of the pesticide.
(c) The time available from discovery or prediction of the pest outbreak is insufficient for a pesticide to be registered for the particular use.

In determining whether an emergency condition exists, the Administrator (EPA) will also give consideration to such additional facts requiring the use of Section 18 as are presented by the applicant.

In cooperation with the States of Oregon, Washington, and Idaho, Colville Indian Reservation, Bureau of Indian Affairs, and Bureau of Land Management, the Forest Service prepared another Draft Environmental Statement during late 1973. It proposed the use of DDT and was filed with the President's Council on Environmental Quality on December 28, 1973. On January 3, 1974, USDA filed an application with EPA requesting an exemption for the use of DDT under Section 18 of the Federal Environmental Pesticide Control Act of 1972. The States of Oregon and Washington also requested a similar exemption from the EPA for use of DDT during 1974.

During the period from January 14-30, 1974, the EPA held four public hearings at Portland, Oregon; Walla Walla, Washington; Coeur d'Alene, Idaho; and Washington, D.C. on the request to use DDT to control the Douglas-fir tussock moth during 1974. At this time there was increasing public pressure to control the tussock moth infestation because of widespread damage which had occurred in Oregon, Washington, and Idaho during 1973. Damaged areas included private farm lots, recreational lots, municipal watersheds, and roadside scenic strips, as well as Federal, State, and private timberlands.

Emergency use of DDT was granted to the Forest Service by the EPA on February 28, 1974, in a formal Order published in the Federal Register on March 5, 1974. The requests of the

States of Washington and Oregon were denied. It was EPA's understanding and expectation that the Forest Service would be able to satisfy all control needs in all three States.

From this point on entomological, operating, monitoring, and pilot project plans for the 1974 season were perfected and items in the EPA order were considered. Five control units were established in Oregon and Washington and two in Idaho. One unit in Oregon and one in Idaho were administered by the respective States while the other five units were administered by the Forest Service. Bids were awarded in April for the purchase, formulation, transportation, and storage of the DDT insecticide, the application by helicopter, and helicopter observation of the spraying.

After a thorough review of more than 450 responses to the Draft Statement, a Final Environmental Statement was filed with the President's Council on Environmental Quality on March 29, 1974. This Final Statement proposed to treat 408,000 acres with DDT after virus incidence had been determined (See Table 1). An additional 74,000 acres needing treatment was proposed for the application of microbial pesticides in a pilot project and small field test plots including untreated check areas on 49,000 acres in Idaho and 25,000 acres in the Blue Mountains of Oregon and Washington. Because of the difficulty in precisely determining all factors likely to affect the location and intensity of the insect populations, the statement provided for the deletion or addition of treatment acres as additional data became available.

Prior to advertising contracts for the aerial application several acreage changes were made. The results of a late egg mass survey in the St. Joe area of northern Idaho added 34,000 acres meeting treatment criteria. A re-evaluation of the egg mass survey carried out in Oregon and Washington resulted in an acreage reduction of 27,000 acres in those States. The results of egg mass surveys covering areas not previously surveyed in Oregon and treatment boundary adjustments based on moving boundaries to topographical or physical features that could be readily recognized from the air, added 49,000 acres in that State. The total area estimated to need treatment at the time of advertising for application contracts in April 1974 was 464,200 acres.

TABLE 1

Acreage Treated with 3/4 lb. DDT by Ownership
Idaho, Oregon, and Washington

Ownership	Acre		Percentage
National Forest			
Idaho	17,318		
Oregon	90,874		
Washington	8,934		
Subtotal		117,126	27.8
BIA			
Coeur d'Alene	3,088		
Colville	145,615		
Umatilla	792		
Subtotal		149,495	35.5
BLM			
Idaho	378		
Oregon	880		
Washington	430		
Subtotal		1,688	.4
Idaho S&P			
State	7,854		
Private	47,716		
Subtotal		55,570	13.2
Oregon S&P			
State	1,374		
Private	66,258		
Subtotal		67,632	16.1
Washington S&P			
State	2,510		
Private	26,923		
Subtotal		29,433	7.0
GRAND TOTAL		420,944	100.0
Total Idaho		76,354	18.1
Total Oregon		160,178	38.1
Total Washington		184,412	43.8
Total		420,944	100.0

By Major Landowner Classification

Federal Lands	118,814	28.2
Indian Tribal Lands	149,495	35.5
State & Private Lands	152,635	36.3
Total	420,944	100.0

Proposed and Actual Acreage Treated by State

Treatment Area	Proposed 1/ Acres	Actual Acres
Blue Mountains	263,122	187,677 2/
Northeast Washington	113,557	167,238
Subtotal Oregon & Washington	376,679	354,915
Northern Idaho (St. Joe Unit)	46,103	76,604 3/
Northern Idaho (Coeur d'Alene Unit)	57,775	
Sawtooth	1,200	1,100
Subtotal Idaho	105,078	77,704
Total — Includes test areas and untreated controls	481,757 4/	432,619 5/
Total — DDT at the 3/4 lb/ acre rate	408,000	420,944

1/ From Final 1974 Environmental Statement — Page 1, B-51, B-185.

2/ Includes 4,710 acres of pilot test spraying with Dylox and Sevin-4-Oil on the Halfway and Wallowa units.

3/ Includes 1,350 acres of pilot test spraying on the St. Joe Unit.

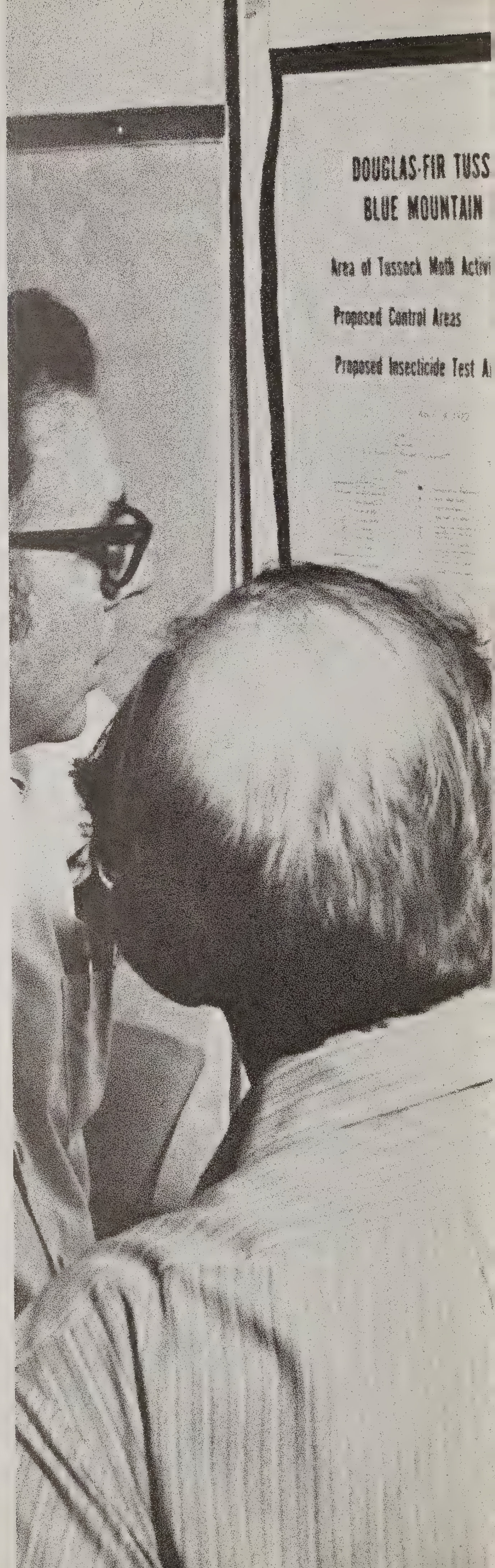
4/ Includes 5,615 acres of reduced dosage DDT testing.

5/ This acreage does not include untreated check areas.

The Colville, Halfway, and St. Joe units treated more area than originally planned. Insect activity on the Pomeroy, Wallowa, La Grande, and Sawtooth units was less than anticipated with a consequent reduction in treated acreage. A microbial project scheduled for the Coeur d'Alene unit had to be cancelled because of low insect populations.

A training meeting of all unit entomologists and assistant entomologists was held in Walla Walla, Washington on May 9 and 10. All aspects of the entomological plan were reviewed in detail. Other meetings for key control personnel followed in quick succession as control operations became imminent.

Staffing of the Walla Walla Project Headquarters and Spray Unit Headquarters at Halfway, Enterprise, and La Grande in Oregon; Pomeroy and Coulee Dam in Washington; Fairfield and Potlatch in Idaho began in mid-May and by late May all were functioning. Cold weather in May caused the insect egg hatch to be later than normal. During this period, block boundaries were adjusted by unit entomologists as necessary, and physically marked on the ground when natural features could not be used. Simulated spray exercises prepared crews for the upcoming spraying. On June 9, 1974, a block of 1,650 acres in the southern portion of the Colville unit was treated with DDT. Three days later an additional 3,000 acres in Stevens County on the east side of the Columbia River were treated. This marked the beginning of the actual control work after many months of preparation.



Planning & Preparation

Preparations for the 1974 tussock moth control project were more complex than those for previous forest insect control projects. The infestation involved three States and three Forest Service Regions, and the use of DDT, an especially controversial chemical.

The Douglas-fir Tussock Moth Interagency Steering Committee was formed in 1973 because of the very complex nature of the Douglas-fir tussock moth problem and the need to bring all of the best expertise available together to develop solutions. Members of the committee included agency heads from the Washington State Department of Natural Resources, Oregon State Department of Forestry, Idaho State Department of Lands, Forest Service (Administration and Research), Bureau of Indian Affairs, Bureau of Land Management, Oregon State University, and the Federal Environmental Protection Agency (advisory capacity only).

Membership of the Interagency Douglas-fir Tussock Moth Steering Committee is displayed on the Steering Committee Chart.

The "doing jobs" for the committee were accomplished by a technical working group designated "The Interagency Douglas-fir Tussock Moth Working Group," and membership in this organization was composed of personnel from Federal and State Agencies that had direct responsibility (by law) for forest insect detection and control. The membership is displayed on the Technical Working Group Chart.

To insure that all concerned landowners and land managers participated in the planning of the actual project, this Working Group coordinated all activities with the Northwest Forest Pest Action Council, Northern Rocky Mountain Pest Action Council, and the Intermountain Forest Pest Action Council. These Councils which included representatives from State and Federal agencies and private landowners provided much of the current public information needed to maintain public interest and support.

In the fall of 1973 the Steering Committee recommended the drafting of a combined Environmental Statement for Idaho, Washington, Oregon, and Montana and reviewed and approved the Final Environmental Statement (Idaho, Washington, and Oregon) as filed with the President's Council on Environmental

Steering Committee Chart
T. A. Schlapfer, Chairman, *Regional Forester, Forest Service, R6*
Steve Yurich, *Regional Forester, Forest Service, R1*
Robert E. Buckman, *Director, Pacific Northwest Forest and Range Experiment Station, Forest Service*
Robert W. Harris, *Director, Pacific Southwest Forest and Range Experiment Station, Forest Service*
J. Edward Schroeder, *State Forester, Oregon State Department of Forestry*
Donald Lee Fraser, *Supervisor, Washington State Department of Natural Resources*
Francis E. Briscoe, *Area Director, Bureau of Indian Affairs*
Jack Gillette, *State Forester, Idaho State Department of Lands*
Carl H. Stoltenberg, *Dean, School of Forestry, Oregon State University*
Archie D. Craft, *State Director, Bureau of Land Management*
George Zappettini, *State Forester, Nevada State Department of Forestry*
Roger Pierpont, Entomologist, *Environmental Protection Agency (Advisory Capacity Only)*

Technical Working Group Chart
David A. Graham, Chairman, *Forest Service, R6*
William M. Ciesla, *Forest Service, R1*
Kenneth H. Wright, *Pacific Northwest Forest and Range Experiment Station, Forest Service*
Benjamin Spada, *Pacific Southwest Forest and Range Experiment,Station Forest Service*
Albert T. Larsen, *Oregon State Department of Forestry*
Les Morton, *Washington State Department of Natural Resources*
R. Ladd Livingston, *Idaho State Department of Lands*
Alfred M. Rivas, *Forest Service, R4*
Bernard Mayer, *Bureau of Land Management*
Greg Stevens, *Bureau of Indian Affairs*
Rick Johnsey, *Washington State Department of Natural Resources*
LeRoy N. Kline, *Oregon State Department of Forestry*

Quality. This committee also reviewed and approved all project suppression, monitoring, and research plans for 1974.

Activities of the Working Group included:

1. Contacts with the EPA involving interpretation of the 11 spray restrictions listed in the February 28, 1974 authorizing order signed by Mr. R. Train, Administrator.
2. Contacts with national news media.
3. Environmental monitoring and DDT procurement.

The following eleven spraying restrictions were listed in the February 28, 1974, EPA authorizing order:

1. The laboratory hatch of egg masses shall be carried out, and all acreage eliminated where larval incidence is too low to justify DDT use or where viral incidence will control the outbreak without such use. The validity of the laboratory data shall be verified by field surveys carried out at the time of natural egg hatch. The Forest Service should make every effort to refine both laboratory and field criteria for the above factors so that no acreage is sprayed unnecessarily.
2. An unsprayed buffer strip of at least 200 feet shall be left along live streams and waterways. Helicopter applicators shall take meteorological conditions into account and adjust spray courses and timing to ensure that DDT does not drift into these buffer zones.
3. Live streams and waterways shall be clearly marked on maps and photo aids for pilots. In addition, these water areas shall be marked with flags, balloons, and kytoons to avoid accidental spraying of water.
4. Payment of applicators shall be related to amount of spray actually reaching the target areas.
5. No spraying is to take place where winds exceed 6 mph, or where temperature inversions exist.[1/] Meteorological conditions shall be verified by competent meteorologists on the ground at the spray site.
6. To the extent possible, livestock and other domestic animals shall be removed from the treatment area; hunters shall be informed as to the possibility of DDT residues in game animals taken from the spray area.
7. A warning shall be prominently placed in public places within all areas to be sprayed, giving the date, time, and duration of the spray project.
8. Applicators shall be licensed by their respective States, and shall be trained both on general procedures and in the field at the site of the spray project. Demonstrable familiarity with the geographical features of the spray area, especially waterways, is essential.
9. Deposition of spray at the target shall be monitored during the actual spray, using appropriately sensitized cards.
10. Spray boundaries shall be indicated by the use of flags, balloons, and kytoons.
11. Complete records of the spray project shall be kept, including locations, quantity, times, and places, and shall be furnished to EPA and the public within 10 days of completion of the project.

Most of these restrictions are standard operating procedures on forest insect control projects and were included in the draft environmental statement. Some restrictions required additional planning and negotiations with EPA. Items six and seven of the Order required many contacts with private landowners, permittees, and the general public. During April and May commercial livestock permittees were notified verbally or in writing of the upcoming spraying and its possible effect on their grazing and livestock marketing plans. State forestry agencies also contacted private landowners in the areas affected in regard to this aspect of the proposed program. News releases pertaining to the DDT Control Project appeared in local newspapers in the affected areas prior to treatment. Stockmen were informed that marketable animals might have to be withheld from market 6 months or more because DDT accumulations of more than 7 parts per million on an adipose (fat) basis were expected if the animals grazed on treated areas. The decision to graze or not graze treated areas was made by the permittee or landowner. Most sheep and many cattle destined for market within the 6-month period were not grazed in the treated area. Some stockmen elected to graze treated areas because of the scarcity of alternate feed.

Post-treatment news releases and public notices advised hunters and the general public of the areas treated and the fact that DDT stored in the

1/ Spraying was, in most instances, carried out under a temperature inversion. EPA officials acknowledged that this particular part of the order was in error.

body fat of game animals in the area could exceed 5 parts per million2/ (See Figures 1, 1A and 1B). Whenever possible individuals were personally contacted if they happened to be in the treatment area.

As required by the order, a DDT label was designed for shipment and use of the DDT mixture (Figure 2).

To comply with item 5 of the order the U.S. Weather Service assigned a meteorologist to each control unit of the project as requested by the Forest Service. They provided the weather reporting and forecasting plan for the unit and trained all of the unit weather observers.

Methods of fulfilling all of the Order obligations were incorporated into the various project plans that were developed prior to actual spray operations.

The Working Group of the Douglas-fir Tussock Moth Interagency Steering Committee designated a committee to develop a plan for sampling and evaluation of treatment effectiveness. This committee prescribed data collection procedures for all control units in order to assess efficacy of the DDT treatments. One of the primary objectives was to standardize evaluation methods in order to directly compare all control units. The final plan outlined procedures which would evaluate the project in terms of (1) target insect mortality, (2) amount of foliage saved, and (3) density of new egg masses after treatment. Committee membership is shown on the Interagency Steering Committee Chart.

In mid-December 1973 an ad hoc work group was called together by the Oregon State Department of Environmental Quality to bring interested agencies together to start planning an environmental monitoring program. By early January 1974 joint meetings were held with concerned State agencies of Washington and Idaho. Each State formed its own interagency group and assigned one agency with overall leadership in that State. The Forest Service assigned an individual as the overall project monitoring coordinator to consolidate plan development for Idaho, Oregon, and Washington. Monitoring committee membership is shown on the Monitoring Committee Chart.

2/ The market meat tolerance level for DDT was lowered from 7 ppm to 5 ppm by EPA on August 13, 1974.

TUSSOCK MOTH CONTROL PROJECT

Public Notice

Aerial Application of DDT to control the Douglas - Fir Tussock Moth infestation is planned for five control units located in Eastern Oregon and Eastern Washington. It is estimated that spraying of the insecticide will begin on or about June 5, 1974 and be completed by July 25, 1974.

Additional information concerning the individual control units can be obtained by writing or calling the Unit Supervisor's office or the Project Director's Office.

COLVILLE UNIT	Randy Perkins, Supvr., U.S. Forest Service Colville Tussock Moth Project, P. O. Box O Grand Coulee, Wa. 99133 Tel: 509/633-1331
POMEROY UNIT	Mike Conner, Supvr., U.S. Forest Service Pomeroy Tussock Moth Project, General Delivery Clarkston, Wa. 99403 Tel: 509/758-3381
WALLOWA UNIT	Roy Sines, Supvr., U.S. Forest Service Wallowa Tussock Moth Project, P.O. Box 539 Enterprise, Or. 97828 Tel: 503/426-3197
LA GRANDE UNIT	Roy Woo, Supvr., U.S. Forest Service La Grande Tussock Moth Project, P.O. Box 1333 La Grande, Or. 97850 Tel: 503/963-7621
HALFWAY UNIT	Bob Metlen, Supvr., U.S. Forest Service Halfway Tussock Moth Project, P.O. Box 899 Halfway, Or. 97834 Tel: 503/742-4902
PROJECT DIRECTOR	Jack Mounts, U.S. Forest Service Tussock Moth Spray Headquarters, Rt. 4 Box 176A Walla Walla, Wa. 99362 Tel: 509/525-3080

T. A. Schlapfer

T. A. SCHLAPFER
Regional Forester

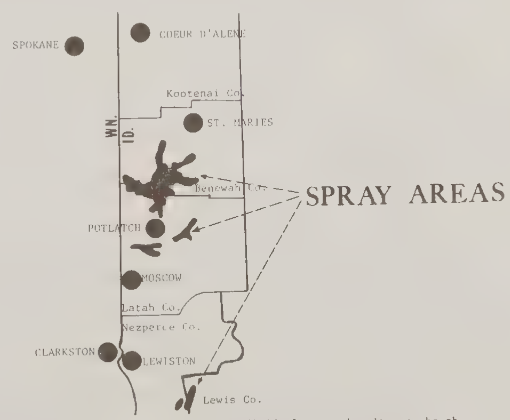
Figure 1

Figure 1A

TUSSOCK MOTH CONTROL PROJECT

PUBLIC NOTICE

Aerial application of DDT to control the Douglas-fir Tussock moth infestation is planned for two control units located in Benewah-Latah and Lewis-Nez Perce Counties of Idaho. It is estimated that spraying of the insecticide will begin on or about June 15, 1974, and be completed by July 25, 1974.



Additional information concerning the individual control units can be obtained by writing or calling the St. Joe Project Director's office.

ST. JOE CONTROL UNIT	Dewey Almas, Project Director, State of Idaho-U. S. Forest Service Cooperative Tussock Moth Project, c/o Potlatch High School, Potlatch, Idaho 83855 Telephone: 208/875-3291
POMEROY UNIT	Dennis Martin, Supervisor, U. S. Forest Service Pomeroy Tussock Moth Project, General Delivery, Clarkston, WA 99403 Telephone: 509/758-3381

GORDON C. TROMBLEY
IDAHO STATE LAND COMMISSIONER

Figure 1B

TUSSOCK MOTH CONTROL PROJECT

Hunter Notice

A number of forested areas in eastern Oregon and eastern Washington were recently treated with DDT to control the Douglas-fir tussock moth. Treatments started on June 9 and were completed on July 25, 1974. A dosage rate of 3/4 lb. DDT per acre was used. Stands treated were all within the shaded areas ( ) on this map.

Past studies indicate that animals, including livestock, deer, elk, and game birds feeding on these areas may exceed the 5 parts per million food tolerance levels presently established for marketed meats. Most of this DDT is stored in body fat for up to 6 months after treatment. Some hunters may prefer to trim off all fat during butchering or to hunt elsewhere because of these treatments. We apologize for any inconvenience this may cause. Additional information concerning the individual treated areas can be obtained by writing or calling the following Federal or State offices:

Umatilla National Forest
2517 SW Hailey Avenue
Pendleton, OR 97801
Tel: 503/276-3811

Colville Agency, BIA
P.O. Box 111
Nespelem, WA 99155
Tel: 509/634-4550

Clearwater National Forest
Orofino, ID 83544
Tel: 208/476-4541

Idaho Panhandle N.F.'s
218 N. 23rd
Coeur d'Alene, ID 83814
Tel: 208/664-8281

Eastern Oregon Area
La Grande District Office
Route 2, Box 2224
La Grande, OR 97850
Tel: 503/963-3168

Wallowa-Whitman National Forest
P.O. Box 907
Baker, OR 97814
Tel: 503/523-6391

Northeast Washington Area
Colville National Forest
Colville, WA 99114
Tel: 509/684-5221

Southeast Washington Area
Route 3, Box 1
Ellensburg, WA 98926
Tel: 509/925-6131

North Idaho Area
Idaho Dept. of Public Lands
Coeur d'Alene Office
P.O. Box 670
Coeur d'Alene, ID 83814
Tel: 208/664-2171

T. A. Schlapfer
T. A. SCHLAPFER, Chairman
Douglas-fir Tussock Moth
Interagency Steering Committee

Figure 2

DDT 3/4 POUND/GALLON

This material is for use **only** under the direction of U.S. Forest Service personnel for the control of Douglas fir tussock moth populations as provided for under Section 18 request [FIFRA as amended by P.L. 92 516 (86 Stat. 973)]. All applications of this material must be in a manner consistent with the Federal Register notice of March 5, 1974, Vol. 39, No. 44, pages 8377 8381, "Use of DDT to Control the Douglas Fir Tussock Moth, Order on Request for an Emergency Exemption." Precautions and monitoring program as provided for in this Order must be carried out in conjunction with application of this product.

Active Ingredients

dichloro diphenyl trichloroethane (DDT)	10.[illegible]
petroleum oil	89.[illegible]

CAUTION

KEEP OUT OF REACH OF CHILDREN

Harmful if swallowed. Do not get in eyes or on skin. Do not breathe vapor fumes or spray mist. In case of skin contact wash with soap and water. Use clean clothing daily.

Do not apply this product where there may be grazing by dairy animals or animals being finished for slaughter. Avoid contamination of feed and foodstuffs.

CLEANING CAUTION:

Decontaminate tank trucks before reusing for transportation or storage of other materials.

FISH AND WILDLIFE CAUTION:

This product is toxic to fish, birds and other wildlife. Keep out of lakes, streams and ponds. Do not contaminate water by cleaning of equipment or disposal of wastes, including decontamination rinses of tank trucks.

Manufactured for

Forest Service - USDA
14th and Independence Avenue
Washington, D.C. 20250

Net Contents ______ GALLONS ______

Interagency Steering Committee Chart

Wayne E. Bousefield — *Forest Service, R1, Missoula, Montana*
Tommy F. Gregg — *Forest Service, R6, Portland, Oregon*
Galen C. Trostle — *Forest Service, R4, Boise, Idaho*
David McComb — *Forest Service, R6, Portland, Oregon*
R. Ladd Livingston — *Idaho State Department of Lands, Coeur d'Alene, Idaho*
Robert Eder — *Forest Service, R1, Missoula, Montana*

Monitoring Committee Chart

Paul R. (Rod) Canutt — *Forest Service, R6, Overall Coordinator*
W. W. (Woody) Benson — *Idaho State Department of Health and Welfare*
Dr. Warren C. Westgarth — *Oregon State Department of Environmental Quality*
Donald O. Provost — *Washington State Department of Ecology*

Operation

An early decision was made to centralize the various insect outbreak areas into one control project, under the direction of an overall tri-state, tri-regional coordinator because of the large amount of scattered area, complex ownership, and the need for extremely close coordination of all operational details.

The Washington and Oregon outbreak was divided into five control units under the direction of a Forest Service project director located at Walla Walla, Washington. The north Idaho outbreak was administered as one control unit by the Idaho State Department of Lands under overall Forest Service direction, with the project director located at Potlatch, Idaho. The southern Idaho outbreak was administered as one control unit by the Forest Service, Region 4, with headquarters at Fairfield, Idaho. Control operations were directed locally by unit supervisors or in the case of Idaho, the project director. The Project Director for Oregon and Washington directed and coordinated the control units in those States. The scope of this control operation was unique in that each of the seven units could have been a separate control project. Personnel from various agencies were integrated into the seven control units (see organization charts, Figures 3 - 10, Appendix).

The location of unit headquarters and responsibility for administration are shown on the Unit Headquarters Chart.

Unit Headquarters Chart

Name of Unit	Location of Unit Headquarters	Administered By
Wallowa	Enterprise, Oregon	Forest Service, R6
Pomeroy	Clarkston, Washington	Forest Service, R6
La Grande	La Grande, Oregon	Oregon State Department of Forestry
Halfway	Halfway, Oregon	Forest Service, R6
Colville	Coulee Dam, Washington	Forest Service, R6
St. Joe	Potlatch, Idaho	Idaho State Department of Lands
Sawtooth	Fairfield, Idaho	Forest Service, R4

8—Personnel from many agencies were involved in various aspects of the project. State fish biologists collected aquatic samples while monitoring streams within the spray area.

9—Temperature, humidity and winds controlled spray operations. La Grande Unit Meteorologist Station was a typical installation.

Personnel and Equipment

Since this was a cooperative project with many ownerships involved, personnel from many State and Federal organizations as well as private companies were involved in both the planning and the doing phases. Personnel having experience and other personnel requesting the opportunity to gain experience on large insect control projects were selected for the various assignments.

A total of 424 people worked directly on all phases of the control project excluding monitoring. Of this total, 304 worked on control and 120 were contract personnel. Over 200 additional people were involved in the monitoring program. Permanent and temporary employees directly involved with the DDT spray control project in addition to contract personnel came from the following agencies: Forest Service - 166; Bureau of Indian Affairs - 45; Oregon State - 40; Idaho State Department of Lands - 41; Washington State Department of Natural Resources - 4; and U.S. Weather Service - 8. EPA Region X assigned 5 employees to observe and report on all tussock moth control project activities including spray applications, additions or deletions of treatment areas, and accidents involving DDT.

Helicopters were selected for applying the insecticide because they could provide more precise application in mountainous terrain, particularly along streams and other identifiable sensitive areas where untreated buffer strips were required.

A total of 16 spray helicopters, 20 observation or administration helicopters (including 1 from the Bureau of Land Management), and 3 fixed wing aircraft were employed on the project. Fifteen contractors including pilots, mechanics, truck drivers, and others spent more than 10,000

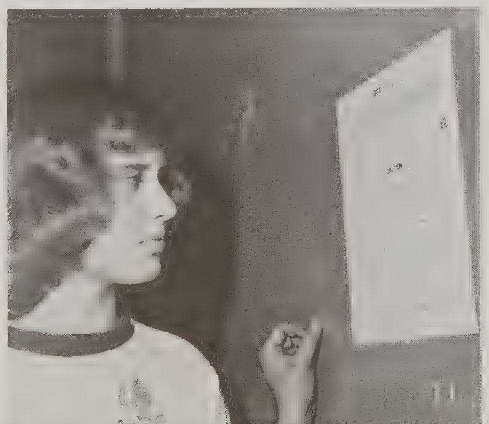
TABLE 2

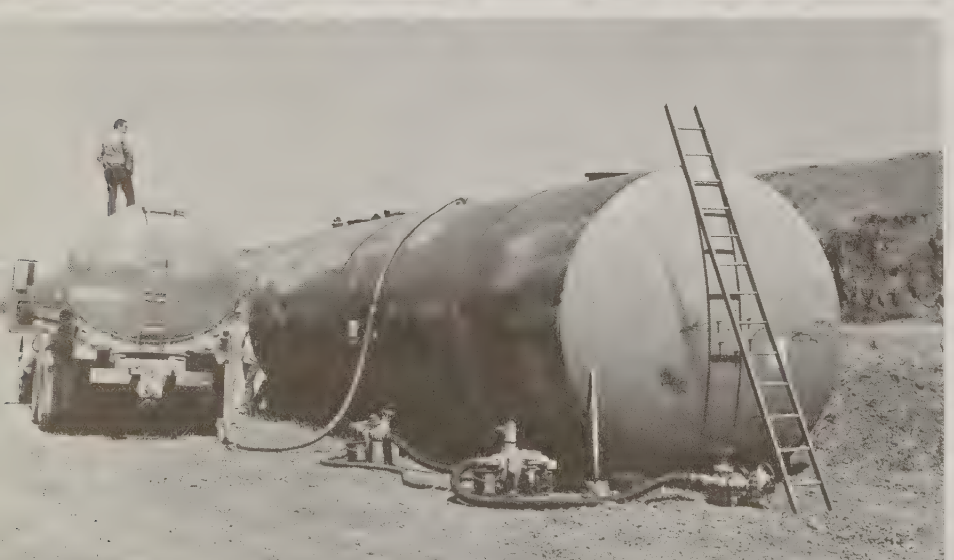
Control Project Personnel

Unit	Control Project	EPA Personnel	Contracting	Total
Project Headquarters	18	1[2/]	12	31
Wallowa	40	1	14	55
Pomeroy	38	1	20	59
La Grande	45	1[2/]	14	60
Halfway	39	1[2/]	20	59
Colville	56	1	21	78
St. Joe	61	1[2/]	15	76
Sawtooth	7		4	11
Total	304	5[2/]	120	429[1/]

1/ An additional estimated 200 people were involved in the environmental monitoring program.

2/ EPA representatives covered 2 control units in some cases.





contractual man hours on the project. The number of personnel assigned to each unit is shown in Table 2.

Contracts

Contracts were let in March and April of 1974 for the following project items or services: (1) Technical Grade DDT; (2) Formulation, transportation, and temporary storage of DDT; (3) Application by helicopter; and (4) Helicopter observation and administrative flight time. Existing contracts were modified in the case of the Sawtooth unit.

a. Montrose Chemical Corporation of California was awarded the contract for DDT in flake form for pickup at their Torrance, California plant. The bid price for the DDT was $0.35 per pound. The total cost was $124,426.

b. The contract to formulate, transport, and store the insecticide was awarded to Harbor Distributing Company of Portland, Oregon at a bid price of $.745 per gallon. Total project cost for this item amounted to $344,414. Significant features of this contract were:

(1) The contractor was responsible for the supply, storage, and mixing of the ingredients. He paid for and made his own arrangements for delivery of the DDT from the supplier.

(2) The insecticide formulation was 3/4 of a pound of DDT dissolved in .94 quarts of auxiliary solvent and sufficient fuel oil to make 1 gallon of solution at 60 degrees Fahrenheit.

(3) The contractor was to furnish 470,000 gallons (± 25 percent) of insecticide and storage facilities at 6 designated locations.

(4) Finished approved insecticide in amounts of not less than 5,000 or more than 25,000 gallons were to be on hand for use at each of the designated locations 5 days after the contractor was notified to begin delivering the insecticide.

(5) The basis for payment was formulated gallons ordered and delivered at the designated storage sites.

(6) All responsibilities of the formulation contractor ended when the insecticide was pumped into the contract applicator's tank trucks.

c. Contracts for applying the material were awarded to a number of firms on the basis of competitive bidding.

Original bid quantities, unit prices, and actual payments under the applicator contracts are shown on the Applicator Contract Summary Chart.

Average hourly production rates for the 5 types of spray helicopters used on the project are shown in the Appendix in Table 3.

d. Significant features of the helicopter application contracts were:

(1) Payments were made on the basis of total gallons sprayed. Increase or decrease of bid item sprayed acres of less than 25 percent would not constitute a basis for adjustment of the contract unit price.

(2) The application contractor to provide transportation of spray solutions from designated storage facilities to operating heliports.

(3) Spray helicopters to be equal to or better in performance to a Bell 47 G3B-1 or Hiller 12E and equipped with dual carburetors and hi-dome pistons were required.

(4) Application of spray to be confined to designated areas at a rate of 1 gallon per acre. A buffer zone of 1 swath width or 200 feet, whichever was greater, was not to be sprayed on each side of designated streams.

(5) Helicopters to be capable of carrying at least 80 gallons of spray.

(6) Spray application heights to range from 40-60 feet above ground cover when terrain and safe flying practices permitted.

(7) Spray pressure at the boom to be calibrated at 40-45 P.S.I. depending upon speed with ranges of 35-45 and 40-50 P.S.I. at speeds of 45-90 mph.

(8) Nozzle systems to be capable of applying spray material at a rate of 1 gallon per acre with an average droplet size of 200 microns, volume median diameter (vmd).

e. Helicopter service contracts were also awarded for observation of spraying and administration of the project on the basis of competitive bidding.

A summary of these service contracts is found in Table 4. The types of service which the aircraft were generally required to perform, but not restricted to, were observation of aerial spraying, general administrative flights, search and rescue missions, cargo transporting, and dropping.

The purpose and intent of the contract was to provide the services of light turbine-powered

Applicator Contract Summary Chart

Item No.	Spray Unit	Contractor	Bid Quantity	Unit	Unit Price	Actual Gallons	Performance Payment
1	Wallowa	Evergreen Helicopters	99,000	acre	$1.55	87,347	$137,394
2	Pomeroy	Reforestation Services	50,000	acre	$1.38	16,437	$ 49,682 1/
3	La Grande	Evergreen Helicopters	84,000	acre	$1.73	35,545	$ 61,508
4	Halfway	Trans-west Inc.	35,000	acre	$1.745	31,377 2/	$ 64,582 3/
5	Colville	Evergreen Helicopters	114,000	acre	$1.55	176,021	$274,876
6	St. Joe	Evergreen Helicopters	81,000	acre	$2.14	75,254	$160,238
7	Sawtooth 4/	Reeder Flying Service	1,200	hour		1,045	$ 2,642
	Totals		464,200			423,026	$750,922

*Payments include change order costs, penalties, etc.
1/ Includes extra payment to contractor for 67 percent underrun in contract.
2/ Does not include gallons of DDT used in reduced dosage test.
3/ Includes estimated extra costs claimed by contractor for low gross weight calculations.
4/ This was a modified fire contract.

10–The contractor had the technical grade DDT shipped to Walla Walla, Washington, where he established a formulation and storage plant.

11–Storage tanks and trucks required a special label.

12–Harbor Distributing Company formulated, transported, and stored the insecticide.

13–Sixteen helicopters sprayed 423,026 gallons of formulated DDT on infested timber stands in Idaho, Oregon and Washington.

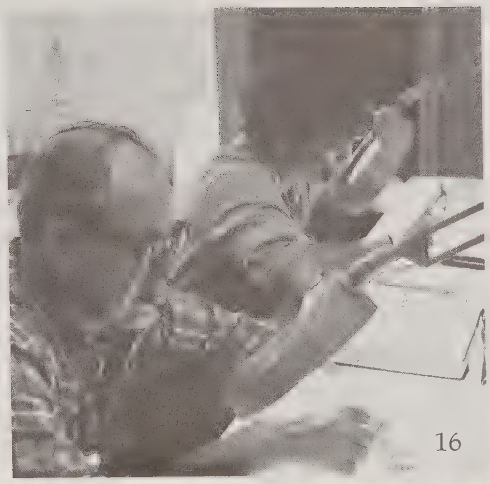
TABLE 4 — Summary of Service Helicopter Contracts

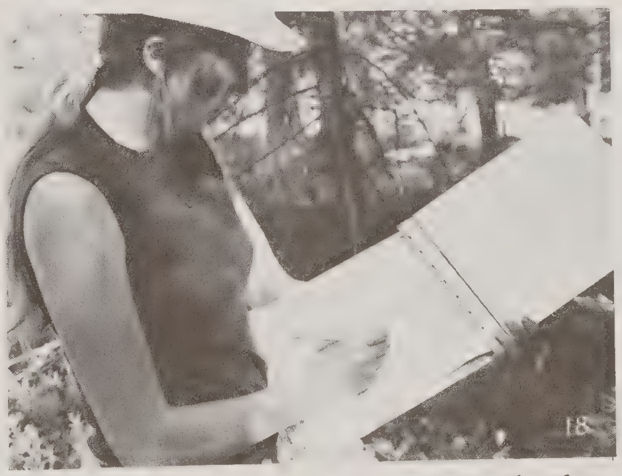
Bid Item No.	Item Helicopters	Contractor	Quantity Days	Unit Price	Hours	Final Dollars
	Wallowa Unit					
1.	1 light turbine powered	Grote Aviation	20	$388/day +140/hr.	135.5	32,510.00
2.	2 piston-powered turbo-charged	Mountain Air Helicopters	40	$385/day +90/hr.	180.3	37,686.80
					315.8	70,196.80
	Pomeroy Unit					
3.	1 light turbine powered	Grote Aviation	20	$348/day +140/hr.	134.9	40,155.00
4.	2 piston-powered turbo-charged	Corvallis Aero Service	40	$350/day +90/hr.	195.1	44,909.00
		Mid Valley		$399/day +90/hr.	42.4	12,320.00
					372.4	97,384.00
	***La Grande Unit**					
5.	1 light turbine powered	Rambling Rotors	20	$389/day +148/hr.	102.0	27,534.00
6.	2 piston-powered turbo-charged	Western Helicopters	40	$340/day +90/hr.	128.6	27,214.00
	Halfway Unit					
7.	1 light turbine powered	Trans/West Helicopters	20	$385/day +140/hr.	118.0	30,572.52
8.	2 piston-powered turbo charged	Cascade Helicopters	40	$399/day +90/hr.	372.3	87,451.00
					490.3	118,023.52
	Colville Unit					
9.	1 light turbine powered	Aero Copters Inc.	20	$430/day +140/hr.	201.0	44,069.00
10.	2 piston-powered turbo charged	Cascade Helicopters	40	$329/day +90/hr.	273.6	46,338.00
		Eastern Helicopters			4.2	1,245.00
					478.8	91,652.00
	***Walla Walla Headquarters**					
11.	1 light turbine powered	Intermountain	20	$360/day +140/hr.	136.0	37,660.00
	1 light turbine powered	B.L.M.			80.1	24,030.00
					216.1	61,690.00
	St. Joe Unit					
	1 Light turbine powered	Skychoppers of Utah		235.00/hr	127.7	34,612.81
	1 Piston-powered turbo charged	Skychoppers of Utah		132.85/hr		
	Sawtooth Unit					
	1 piston-powered turbo charged	Reeder Flying Service		140.00/hr	9.7	2,225.00

*Contract helicopters assigned from other areas, such as the Willamette National Forest.

14—Observation helicopters were also used to ferry entomologists to field plots or for general reconnaissance and administration.

15—Assistant Project Director John Hughes, Project Director Jack Mounts, and Spray Operation Officer Ben Siminoe check map of spray areas on Halfway control unit.





16—Field checks and sampling.

17—Entomologists determined final spray areas on the basis of a continuous biological evaluation of the tussock moth population.

18—Recording data.

helicopters and piston-powered turbo-charged helicopters fully operational, for use in observation of aerial spraying and other project activities during the designated availability period.

Significant features of the helicopter service contracts were:

(1) During the designated availability period, helicopters must be available for use at all times as specified by the contracting officer, fully operational and ready for take off.

(2) One service truck, attended by a helper or the certified mechanic, was required for each helicopter. Such trucks had to be capable of hauling 1 full day's fuel supply (8-flight hours) for the helicopter for extended periods of time.

(3) Minimum helicopter specifications were as follows:

Turbine-powered helicopters must:

a. Be five place.

b. Have a 400 shp engine installed.

c. Carry a 1,200 pound useful load.

d. Have an FAA and factory approved extended leg configuration with assist steps installed.

Piston-powered, turbo-charged helicopters must:

a. Be a Bell 47-G3B, 47-G3B-1, 47-G3B-2, 47-G3B-2A, or a Hiller SL3 or SL4.

b. Be able to carry a 1,000 pound useful load.

c. Have an FAA approved extended leg configuration.

(4) The Pilot-in-command was to be responsible for the safety of the helicopter, its occupants, and cargo. He had complete authority to postpone, change, or cancel any flight when he believed existing or impending conditions made it unsafe.

(7) After award of the contract, but not less than 3 days before the start of the designated availability period, an inspection of all helicopters, pilots, relief pilots, and the service facility was to be made.

(6) Payment in Oregon and Washington was to be on the basis of flight hours and daily availability. The hourly flight rate for light turbine-powered helicopters was $140.00 per flying hour and $90.00 per flying hour for piston-powered turbo-charged helicopters. Daily availability was the basis for bidding. Twenty days availability were guaranteed for the light turbine-powered helicopters and 40 days for the 2 piston-powered turbo-charged helicopters on each control unit in Oregon and Washington. The availability period was set at June 1, 1974, through July 1, 1974, and the contractor was obligated to perform for a period not to exceed 10 days before or after these dates. Payment in Idaho was on the basis of flight hours only.

Release of Spray Blocks

Unit spray blocks were designed to provide areas in which the insect egg hatch was expected to occur uniformly. Spray block boundaries were usually easily recognizable features such as ridges, streams, meadows, or roads. Three or more egg hatch plots were established at different elevations and aspects throughout each block.

Each plot consisted of 20 new egg masses with no more than 3 per tree. Each egg mass was marked with a small paper tag and plastic ribbon. Egg masses were observed intermittently after

TABLE 5-Acreage Treated by Control Unit								
	Planned 1/		Treated Planned		Red Top Areas 2/		Total Treated	
Unit	Blocks	Acres	Blocks	Acres	Blocks	Acres	Blocks	Acres
Halfway	58	35,000	43	28,015	6	5,695	49	33,710
Wallowa	26	99,000	25	79,917	7	8,500	32	88,417
La Grande	50	84,000	26	29,377	16	8,674	42	38,051
Colville	36	114,000	24	113,128	12	54,110	36	167,238
Pomeroy	29	50,000	7	17,174			7	17,174
St. Joe	35	81,000	31	73,072	3	2,182	34	75,254
Sawtooth	3	1,200	3	1,100			3	1,100
Totals	237	464,200	159	341,783	44	79,161	203	420,944

1/ Planned acreages based on estimates at time of contracting.

2/ Areas added to the treatment program on the basis of visible defoliation as determined by aerial surveys. Includes all or portions of some planned spray blocks and some new blocks.

budburst until egg hatch began and daily thereafter. Spray blocks were released for treatment by the unit entomologist 3 days after 70 percent of the egg masses on the plots in a block started to hatch. This was done in most cases by a written notification to the Unit Supervisor. Results were also posted currently on large charts at each project headquarters.

If more than one block became ready for treatment at the same time, the unit supervisor, entomologist, and spray operations officer jointly decided on the treatment priority. The unit supervisor or his alternate then oriented spray and observation pilots, monitoring coordinators, and other key personnel on spray block treatment sequence and upcoming spray operations.

Some spray blocks were placed in a deferred status because little or no egg hatch developed on the plots. About 106,000 acres planned for treatment were deferred on the basis of prespray sampling. These and adjacent areas were aerially surveyed for defoliation and ground checked periodically during the summer. Some 155,000 acres of land not previously scheduled for treatment were treated because of visible defoliation observed during aerial surveys and newly discovered populations.

Treatment

A total of 420,944 acres were treated with 3/4 lb. of DDT per acre. The number of acres treated within each of the 7 control units are shown in Table 5 and illustrated on maps 11 - 17. A breakdown by ownership is shown in Figure 11, Appendix. It required 40 spray days to complete the project. An additional 5,615 acres were treated with DDT at rates of 1/4 and 1/2 lb. per acre.

Topographical features on the 7 control units varied from rolling foothills to steep rugged ridges and deep canyons. Some of the most rugged treatment areas were located on the Pomeroy and Halfway units. Elevations ranged from 2,500-6,500 feet above sea level.

Heliports were located in natural openings such as meadows, open ridgetops, clearcuts, rock outcrops, or roadways that were accessible to tank trucks. Ninety-four heliports were utilized on the 7 control units.

Each contract helicopter was inspected by the Project Air Officers for air worthiness, contractual specifications, and suitability for the work. He also checked the qualifications and proficiency of contract pilots and assisted in the calibration of spray aircraft. Simulated spray exercises were conducted prior to actual operations.

Because of the late spring and heavy snow pack, spraying did not begin until June 9. The first blocks to be treated were located on the Colville unit. Spraying elsewhere was delayed until after June 17. Thereafter, weather conditions were suitable for spraying except for

some windy days and a few rain showers (See Tables 6 - 11, Appendix).

Approximately 679 flight hours were required to treat the 7 units for an average production rate of 620 acres per hour. On this project the large Bell 205 A-1 helicopter had an hourly production rate exceeding 900 acres per hour, or more than 3 times the average of smaller ships such as the Hiller 12E or Bell 47 G3B-2.

During a 2 week period from June 18 through July 2 when all or almost all 7 units were in operation, an average of 23,844 gallons were sprayed daily. The greatest production occurred on June 25, 1974, when 30,697 gallons were applied by 6 of the units. On 1 day the Colville unit sprayed 15,650 gallons for the greatest daily unit production during the project.

Observation and administrative helicopters flew a total of 2,241 hours on the 7 units and project headquarters at a total cost of $530,533. These ships were used for a wide variety of activities including locating heliports, ferrying personnel, inspections, hauling cargo, spray block boundary marking, and the "red top"3/ survey. However, their primary function was to monitor the spray application.

Observation helicopter time and costs were higher than anticipated because of the late spring and heavy snow pack. At higher elevations the only means of access was by helicopter because of snow blocked roads. When the weather moderated in June, spring floods made many roads impassable. Entomological crews were heavily dependent upon helicopter transportation for making their prespray surveys. Observation aircraft use summaries are shown in Table 14, Appendix.

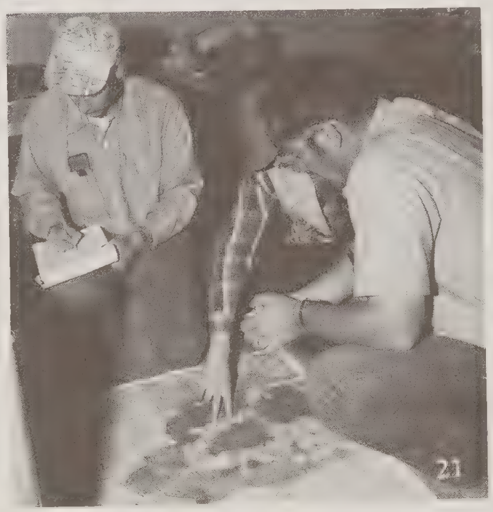
Pesticide Spills

There were 5 significant accidental DDT spills or misapplications during the project. The first occurred on June 17 in the Cookstove area of the Sawtooth unit in Idaho. The pilot, using unfamiliar equipment, triggered the dump valve and the spray valve switch simultaneously. This error resulted in the spreading of 60 gallons of DDT mix on slightly more than 1 acre. Because of the remoteness of the area and distance from streams, no cleanup action was taken.

The second DDT insecticide accident happened on the Pomeroy unit in Washington on June 23 when a Bell 47 G3B-2 spray helicopter crashed with 60 gallons of insecticide. All but about 15 gallons burned in the ensuing fire. This crash was over 1/4 mile from the nearest water course. The soil was turned over in the area of the spill to bury any excess unburned insecticide.

The third accident developed when a Hiller 12E spray helicopter lost power and had to dump 60 gallons of insecticide to prevent a crash. This happened on the Wallowa unit in Oregon on July 19. The nearest stream course was approximately 0.4 miles from the accident. The landowner requested that the site not be disturbed so no clean up action was taken.

On June 20 an estimated 50 gallons of formulated DDT were spilled on the Colville unit. A hose on a tank truck ruptured while



19—Spills were cleaned up by absorbing the insecticide with charcoal and burying the resulting residue.

20—To prevent possible accidents to insecticide trucks, all tankers were piloted to helispots by personnel familiar with roads and helispots.

21—All spray pilots were briefed on areas to be sprayed before actual flights.

22—Rugged canyons presented operational hazards.

3/ A special periodic aerial survey used to locate additional high population areas needing treatment.

Accident Summary Chart

Unit	Personal Injuries	Motor Vehicle Accidents	Aircraft Accidents	Aircraft Incidents
Wallowa	1	1	1	
La Grande		4		
Pomeroy		2	1	2
St. Joe		1		
Sawtooth				1
Halfway	1	1		2
Colville			1	1
Totals	2 1/	9 2/	3	6

1/ Personal injuries requiring medical treatment include a bruised shoulder and cut instep.

2/ The motor vehicle accidents were minor in nature involving mostly dented fenders.

Spray Card Summary Chart

	Spray Areas		Sensitive Areas		
Unit	Card Lines	No. of Cards	Card Lines	No. of Cards	Total Cards
Wallowa	52	1,732	20	1,108	2,840
Pomeroy	14	462	2	95	557
La Grande	44	1,521	10	267	1,788
Halfway	50	1,627	39	555	2,182
Colville	49	2,133	18	650	2,783
St. Joe	61	1/	20	1/	1/
Sawtooth	6	1/	1	1/	1/

1/ No record maintained of number of cards in each card line.

filling a helicopter. The spill was hosed down with water and the soil turned and covered with fresh soil. A few days later, when equipment was available, a bulldozer dug a 3-foot deep trench into which alternate layers of charcoal and soil were mixed. The site was covered with fresh soil, packed down, and sown with grass seed.

An overspray into a streamside strip occurred on the main fork of Meacham Creek on the La Grande Unit on June 24. Spray cards along the stream indicated dosages of up to .3 gallons per acre along a short stretch of the stream. The overspray apparently took place when the spray was shut off late on 2 passes. Local EPA and monitoring personnel were immediately notified. They visited the area and reported no significant short-term adverse effects.

Several additional minor spills were cleaned up by absorbing the insecticide with activated charcoal and burying all of the material in areas where water contamination would not occur.

Aircraft Accidents

There were 3 serious or potentially serious helicopter accidents on the project. All of these involved contracted spray or observation aircraft. On June 14 a Bell 205 A-1 spray helicopter owned by Evergreen Helicopters Inc. clipped a set of powerlines near heliport #15 on the Colville unit. Extensive damage resulted to the helicopter's spray boom and several powerlines were severed. There was no bodily injury and no DDT was spilled.

The second and most serious accident happened at 5:53 am on June 23 when a Bell 47-G3B-2 helicopter owned by Mountain Air Helicopters and contracted to Reforestation Services Inc. crashed and burned while spraying near Saddle Butte on the Pomeroy unit. The helicopter was completely destroyed by the ensuing fire, but the pilot managed to escape with minor cuts and bruises.

The third accident occurred on July 21 when a Wallowa unit observation helicopter pilot misjudged his landing approach and "pancaked." Extensive damage resulted to the ship's main rotors. The pilot was uninjured.

Safety

Safety was given major emphasis during all phases of this project. A Safety Officer was assigned to the Oregon-Washington project headquarters at Walla Walla. In addition, each large control unit had a Safety Officer who managed the safety program for all personnel on the unit. It was his job to carry out the safety plan that was written for the project, the Forest Service Safety Handbook instructions and other safety requirements on all phases of the project.

The safety objectives of the 1974 Douglas-fir Tussock Moth Control Project Safety Plan were to carry out the spray program with no fatalities, no lost time injuries, and no property damage accidents in either the Forest Service or contractor organizations. There were no fatalities or lost time accidents; however, one helicopter spray ship was destroyed and two other helicopters sustained property damage. Considering the topography, work conditions, number of people involved, and inexperience of some of the personnel, the safety record was

excellent. Results are recorded on the project accidents summary chart.

Spray Deposition

In order to determine spray deposit, oil sensitive cards were placed at 100-foot intervals on a variable number of spray checklines running at right angles to the spray swath depending on size and shape of spray block. The spray droplet pattern on each card was compared visually against the "Standards for Estimating Airplane Spray Deposits on Oil-Sensitive Cards" (Davis et. al. 1954). Deposits of 0.20 gallons per acre or more for each card were considered satisfactory. If three or more successive cards had unacceptable spray deposits the checker notified the spray operations officer that there was a possibility that respraying might be required. Further checks were necessary to determine whether or not the area would need to be resprayed. The second examination included checking for foliage burned by spray deposit and the presence or absence of dead larvae in the spray area. Although some spray deposit cards revealed a few untreated spots, there was no need to respray any of the treated blocks.

The number of spray cards and card lines used are shown on the Spray Card Summary Chart.

In sensitive areas along streams, 1 line of cards was located parallel to the stream and as close to the stream as possible. Cards were spaced at 100 foot intervals for at least 1 mile. In addition to this card line, at least 1 line of cards was placed at right angles to the stream. These cards were spaced 50 feet apart along the line out to 200 feet. Spray deposit assessment of these cards was the same as that used for the spray blocks. As indicated previously, one stream overspray occurred in the Meacham Creek area on the La Grande unit. Significant streamside spray deposit was also recorded on Boulder, Hangman, and Bunnel Creeks on the St. Joe unit. Many of the spray cards next to the stream edge on all units received minor amounts of drift even under ideal spraying conditions. In many instances the 200-foot buffer strip was not wide enough to prevent drift into the streams. Some buffer strips were widened in order to more adequately protect streams.

Costs

Total project control costs were $2,980,000 or $7.08 per acre. A detailed summary of costs is shown in Table 15, in Appendix. Costs were shared by State and Federal agencies and private landowners under authority provided in the Forest Pest Control Act of June 25, 1947.

In Idaho, Washington, and Oregon the Federal government paid the full control costs on Federal land and 50 percent of the cost on private and State land. The States of Oregon and Washington paid 25 percent of the cost on private land and 50 percent of the cost on State land. Private landowners paid 25 percent of the cost of control on their land in these two states. In Idaho, a special insect control fund set up from timber slash disposal collections was used to pay the costs on private lands.

Public Relations

Newspaper, radio, and television coverage of the project was excellent. Considerable nationwide publicity was received. An Information and Education Coordinator was assigned to Oregon and Washington project headquarters and to each large control unit. Daily status reports were provided to news media and others during spraying operations. Organized "Show Me Trips" of the spraying on the Colville, St. Joe, and Halfway units were conducted for news media people and other interested groups.

Treatment Effectiveness

Treatment effectiveness was based on (1) target insect mortality, (2) amount of foliage saved, and (3) density of new egg masses after treatment. Based on prior sampling experience and estimated variances, a total of 75, 3-tree clusters were examined in most control units. This consisted of 60 treated clusters and 15 untreated clusters. However, it was necessary to adjust the number of clusters examined on some units due to unforeseen changes in insect development.

The basic unit of measurement was the mean tussock moth larvae population per 1,000 square inches of foliage on each cluster.

Target Insect Mortality

Douglas-fir tussock moth larval populations per 1,000 square inches of foliage were computed for prespray, 4-day postspray, and 21-day postspray sampling periods, in each of the treated and untreated clusters in each control unit (Table 16). Mortality and survival ratios were computed for each unit using Abbotts formula[4/].

The effect of DDT on Douglas-fir tussock moth larvae was dramatic. The 4-day postspray population corrected mortality on all units, weighted by acres sprayed, was 96.8 percent. Individual units ranged from a low of 89.8 percent to a high of 98.5 percent. The 21-day postspray corrected mortality for all units was 98.84 percent and ranged from a low of 91.8 to a high of 99.5 percent (Table 17).

An unpaired T test used to test differences in survival ratios between treated and untreated clusters for the 4 and 21 day postspray evaluation showed that population survival was reduced significantly because of treatment (Table 18, Appendix).

Foliage Saved

Two methods were used to determine the effect of treatment on the amount of foliage saved. One method measured differences in percent of needles damaged between treated and untreated areas on current year's foliage 21 days after spray application. The other method measured visual differences in both new and old growth defoliation intensity on pre-selected trees in treated and untreated areas.

1. *Needle damage assessment 21 days after treatment.*

The proportion of needles destroyed was obtained prior to treatment and 21 days after

4/ Abbott's formulas considers natural mortality in the untreated areas.

TABLE 16

Population of Douglas-fir Tussock Moth by Control Unit and Sampling Periods

Control Unit		Prespray1/	4 days postspray	21 days postspray
Colville —	treated	67.08[2/] ± 11.82[3/]	0.97 ± 0.42	0.21 ± 0.08
	untreated	33.68 ± 15.87	13.37 ± 4.67	9.38 ± 2.53
Pomeroy —	treated	21.61 ± 3.93	0.16 ± 0.12	0.08 ± 0.05
	untreated	6.06 ± 2.26	2.18 ± 0.88	1.03 ± 0.30
Halfway —	treated	20.16 ± 4.59	0.37 ± 0.14	0.10 ± 0.40
	untreated	14.57 ± 4.23	11.09 ± 3.82	4.75 ± 1.61
La Grande —	treated	25.62 ± 3.59	0.28 ± 0.12	0.008 ± 0.01
	untreated	24.57 ± 8.59	9.51 ± 3.27	1.42 ± 0.83
Wallowa —	treated	39.84 ± 8.39	0.65 ± 0.31	0.09 ± 0.06
	untreated	79.30 ± 21.00	31.73 ± 7.43	16.83 ± 6.35
St. Joe —	treated	28.20 ± 5.22	0.55 ± 0.51	0.06 ± 0.06
	untreated	10.72 ± 1.69	9.40 ± 1.59	5.14 ± 1.49
Sawtooth —	treated	10.09 ± 2.07	0.44 ± 0.13	0.42 ± 0.13
	untreated	7.99 ± 2.85	3.47 ± 1.29	4.05 ± 1.70

1/ Prespray population densities were determined when 70 percent of the egg masses had begun to hatch.

2/ Population means expressed in tussock moth larvae per 1,000 square inches.

3/ One standard error.

TABLE 17

Douglas-fir Tussock Moth Mortality at 4- and 21-day intervals Following Spraying with 3/4 pound of DDT per acre[1]

Control Unit	Acres Treated	4-day Postspray	21-day Postspray
		— Percent —	
Colville	167,238	96.4	98.9
Pomeroy	17,174	98.5	97.8
Halfway	33,710	97.6	98.4
La Grande	38,051	97.2	99.5
Wallowa	88,417	95.9	98.9
St. Joe	75,254	97.8	99.6
Sawtooth	1,100	89.9	91.8
Total	420,944		
Weighted Average		96.78[2/]	98.9[2/]

1/ Corrected for natural mortality using Abbotts formula.
2/ Weighted for acres treated in each unit.


23—Photo of branch from tree in controlled area shows loss of old growth foliage (1973) but full needle compliment of new growth saved by DDT.

24—Defoliated branch with few tufts of new growth has small chance of recovery. The tufts are shrivelled and turning brown.

25—Ground photo of defoliated trees (cover photo, lower left) shows total foliage destruction of new and old growth during 1973 and 1974. Tree survival is not anticipated.

26—Application of DDT insecticide saves most of current foliage and assures stand of continuing recovery from defoliation.

treatment by counting damaged and undamaged needles from branch samples brought to field laboratories. Percent needle damage for each cluster was obtained and transformed into arcsin to more heavily weigh the small percentages allowing the data to conform to a normal distribution.

The analyses showed that significant differences occurred between treated and untreated clusters on the Halfway, Wallowa, St. Joe, and Sawtooth control units in percent of needles damaged 21 days after treatment. Some units showed significant differences between untreated checks and treatments on the prespray samples (Table 19, in Appendix). Regression analyses show that defoliation (Y) was caused by tussock moth population (X), and also showed that treatment was effective in preventing continued feeding in treated areas on all control units (Figures 12 - 18, Appendix).

2. *Postfeeding visual damage estimates.*

Prior to the spring feeding each pre-selected tree was rated as to existing defoliation intensity on old and new foliage. A defoliation index from 0 to 3 for each of six crown levels was visually measured on each tree and the mean defoliation index for the cluster was computed. This index was used as the base to determine if additional foliage loss occurred in 1974.

Postfeeding examinations were conducted by the same individuals who made the prefeeding examinations. Defoliation indexes were determined for each tree using the same type of rating system. After all feeding was completed, the analysis showed significantly more feeding occurred on the new growth in untreated areas than on the treated areas (Table 20).

The same analysis was used to evaluate treatment effect on old growth. Only the Wallowa and Colville units showed that old growth foliage was saved. If other units had higher untreated check plot populations, differences could probably have been detected (Table 21). The regression lines for both new and old foliage are shown in Figures 19 - 25, Appendix.

Egg Mass Density

Two whole mid-crown branches were removed from each sample tree in September-October. The number of new egg masses per 1,000 square inches of foliage was calculated on both treated and untreated areas for all control units.

New egg masses were found in the untreated portions of the Pomeroy, La Grande, Wallowa, and St. Joe units. New egg masses were also found in some treated areas on the La Grande and Pomeroy units. However, the frequency and density of new egg masses were lower in all treated areas except those on the Pomeroy unit (Table 22).

Discussion and Conclusions

The results of the various analysis leaves little doubt that DDT was effective in reducing tussock moth populations to acceptable levels. The treatments also prevented further needle destruction and saved new growth. The analysis showed that where high populations existed old foliage was also saved. It should be pointed out that defoliation at mid-crown where evaluations were made is not representative of the most severely defoliated portion of the tree, but reflects the average. Research has shown that defoliation by the tussock moth causes a reduction in diameter growth at all levels of tree height examined, but is most pronounced in the upper part of the tree where feeding damage is normally heaviest. In previous studies, areas of heavy defoliation suffered a 63.5 percent growth reduction in the merchantable size trees. Growth recovery in unkilled trees was not complete until the fourth and sometimes fifth year (Wickman, 1963). As many as half of the trees that have 50 to 75 percent of their crowns defoliated suffer top-kill (Wickman, 1963).

Bark beetles are also a potential threat to the trees weakened by defoliation due to the tussock moth. In one infestation 75 percent of the total tree mortality was due to attack by beetles. This type of mortality continued for four years after defoliation and occurred primarily in merchantable sized trees (Wickman, 1958). Salvage programs can harvest mortality and weakened trees but are disruptive to the orderly harvest of the forest.

Foliage protection achieved in 1974 prevented further growth loss, top-killing, and tree mortality in all areas treated.

TABLE 20

Covariance Analysis of Regression Lines Obtained From Visual Estimates of Crown Defoliation on the Current Year's Foliage

Control	Unit	Test for differences in slope: Regression coeficient	Degrees of freedom	F	Test for differences in elevation: Adjusted means 1/	Degrees of freedom	F
Colville —	treated	0.0249	1/77	5.74**	2.598	1/78	2.73*
	check	.0571			4.360		
Pomeroy —	treated	-.0104	1/44	0.00 NS	.9449	1/45	2.05 NS
	check	-.0093			.2073		
Halfway —	treated	.0161	1/65	1.61 NS	1.1400	1/66	28.77***
	check	.0522			4.2320		
La Grande —	treated	.0181	1/73	5.27**	.4662	1/74	9.10***
	check	.0468			1.6401		
Wallowa —	treated	.0221	1/74	1.35 NS	1.2400	1/75	81.95***
	check	.0311			7.0600		
St. Joe —	treated	.0239	1/69	12.57***	.3001	1/70	26.67***
	check	.1646			2.2530		
Sawtooth —	treated	.00036	1/81	175.65***	.001516	1/82	31.25***
	check	.1353			1.4610		

NS — Nonsignificant

* 10 percent significance level
** 5 percent significance level
*** 1 percent significance level

1/ Adjusted mean defoliation index for current year's foliage.

TABLE 21

Covariance Analysis of Regression Lines Obtained from Visual Estimates of Crown Defoliation on the Old-Growth Foliage

Control Unit		Test for differences in slope: Regression coefficient	Degrees of freedom	F	Test for differences in elevation: Adjusted means 1/	Degrees of freedom	F
Colville —	treated	0.0077	1/77	4.04**	0.6064	1/78	2.01 NS
	check	.0184			1.1960		
Pomeroy —	treated	-.0072	1/44	.011 NS	.9253	1/45	2.53 NS
	check	-.0109			.3619		
Halfway —	treated	.00419	1/65	1.564 NS	1.4210	1/66	.842 NS
	check	.0320			1.0030		
La Grande —	treated	2/					
	check	2/					
Wallowa —	treated	.00318	1/74	17.47***	.1267	1/75	49.28***
	check	.00963			1.2080		
St. Joe —	treated	.00068	1/69	1.033 NS	.0415	1/70	.572 NS
	check	.00891			.1232		
Sawtooth —	treated	2/					
	check	2/					

NS — Nonsignificant

* 10 percent level
** 5 percent level
*** 1 percent level

1/ Adjusted mean defoliation index for old-growth foliage.
2/ No defoliation occurred on old foliage in these control units.

TABLE 22

1974 Fall New Egg Mass Densities per 1,000 Square Inches Foliage

Control Unit	Treated Clusters	Untreated Clusters
St. Joe	0	0.04190
Sawtooth	0	0
La Grande	.00068	.01360
Wallowa	0	.00294
Halfway	0	0
Colville	0	0
Pomeroy	.04250	.01110
MEAN	.00618	.01009

Environmental Monitoring

An extensive monitoring program to measure the levels of DDT before, during, and after spray application was conducted by various State and Federal agencies, and universities. This program was coordinated by the Interagency Monitoring Committee. Each control unit was assigned a monitoring liaison whose principal duties were to: (1) provide information on current spraying plans, (2) develop a communication system permitting timely transmission of project spray plan changes to monitoring personnel, (3) receive and log biological samples and ensure that samples were properly stored, (4) coordinate monitoring of accidental pesticide spills, (5) coordinate damage claims investigation, (6) inspect operational areas and procedures to insure that undue environmental contamination was avoided, (7) provide information relating to the monitoring program to visiting scientists, (8) provide assistance in collecting samples, and (9) maintain a complete log of daily activities pertaining to the monitoring program.

Major monitoring efforts were directed at evaluating DDT residues in water, air, vegetation, litter, stream sediment, aquatic organisms, fish, birds, deer, elk, sheep, coyotes, chipmunks, mice, shrews, human blood, milk, and cattle, and effects on aquatic organisms, larch casebearer parasites and forest birds.

Except for a temporary heavy kill of aquatic insects in some streams, very little short-range adverse environmental effects occurred. One study by Evergreen State College showed that some songbird mortality was caused by the DDT. As expected, domestic livestock and wildlife grazed on treated areas were found to have body fat DDT levels that exceeded the legal tolerance level for marketable meats.

Final results of the short range environmental monitoring will not be known until late in 1975. Preliminary results are given in the "Interim Report of Environmental Monitoring of Nontarget Organisms in the 1974 DDT/Tussock Moth Control Project in Idaho, Oregon, and Washington," U.S. Forest Service, February 1975.

Final reports on all the environmental monitoring will be published as soon as the various programs are completed.

Recommendations For Future Projects

During the planning phase of the project, recommendations from previous control projects were reviewed. Several of these were incorporated into the operational plans. A 2-day critique of this project by all administrative personnel further re-emphasized these previous recommendations and identified several new ones.

The following recommendations are considered applicable to all future forest insect aerial application control projects of a similar nature:

1. There is a need for an overall coordinating and planning organization involving all landowners and agencies whenever an outbreak occurs.
2. "Ad hoc" planning teams should be formed to make resource allocation decisions. They should also decide for or against control in all areas, depending on management objectives. They should also decide on width of untreated streamside and other water zones for all stream classifications.
3. An economist should be assigned to the project planning team.
4. All personnel and especially those in key positions should be as well informed as possible on all phases of the project, especially as it applies to their individual job.
5. As much authority as possible should be delegated to operational units.
6. Supplemental methods of sampling should be developed to assure that areas requiring treatment will be treated before damage appears and that other areas will not be treated unnecessarily.
7. A skills bank should be developed to identify people willing and able to fill key control project positions.
8. Fixed wing aircraft should be considered for non-critical area spraying.
9. A different radio frequency should be assigned to each control unit.
10. Aircraft gross weights should be standardized by all agencies.
11. Extra personnel should be available to relieve key people in jobs such as: heliport manager, dispatcher, maps and records officer, and load checkers.

12. Demobilization and contingency plans should be included in the project operational plan.
13. Monitoring personnel on each unit should be placed under the direction of the unit Monitoring Coordinator in order to improve communications between monitoring and control personnel.
14. Monitoring Coordinators should not do field monitoring themselves. They should function strictly as full time supervisors and coordinators.
15. A method should be developed to increase spray capability during periods of rapid egg hatch to assure spraying during optimum insect development, prior to the occurrence of serious damage.

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Appendix

Project Organization Charts, Figures 3 - 10.

Regression Analysis of New Foliage During Period Between Prespray and 21 day Postspray Evaluation, by Control Units; Figures 12 - 18.

Regression Analysis of Visual Damage to New and Old-Growth Foliage Expressed as an increase in Defoliation Index, By Control Units; Figures 19 - 25.

Production and Flight Hours by Type of Helicopters, Table 3.

DDT Treatment Summaries, Tables 6 - 12.

Daily Record of DDT Spraying, Table 13.

Production and Flight Hours of Helicopters by Control Units, Table 14.

Project Cost Summary, Table 15.

Survival Ratios for Treated and Untreated Clusters by Control Unit, Table 18.

Variance Analysis of Regression Lines from Measuring Damaged Needles by Sampling Periods, Table 19.

Pie Charts of Acreage Treated by Ownership, Figure 11.

Maps of Progress of Infestation, Map Nos. 1 - 10.

Maps of Treated Areas, Map Nos. 11 - 17.

FIGURE 3

PROJECT HEADQUARTERS ORGANIZATION

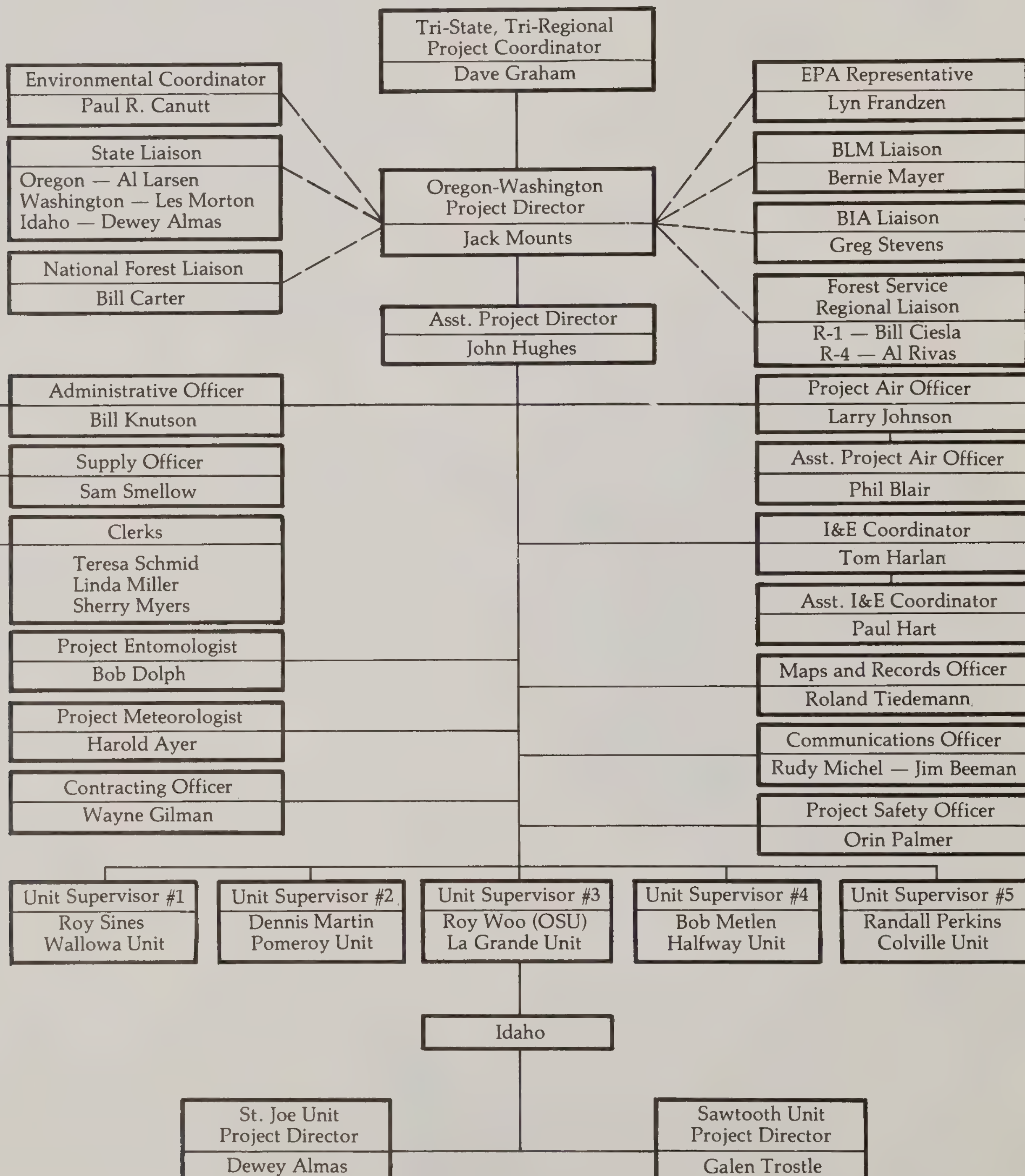


FIGURE 4

WALLOWA UNIT #1
UNIT HEADQUARTERS ORGANIZATION

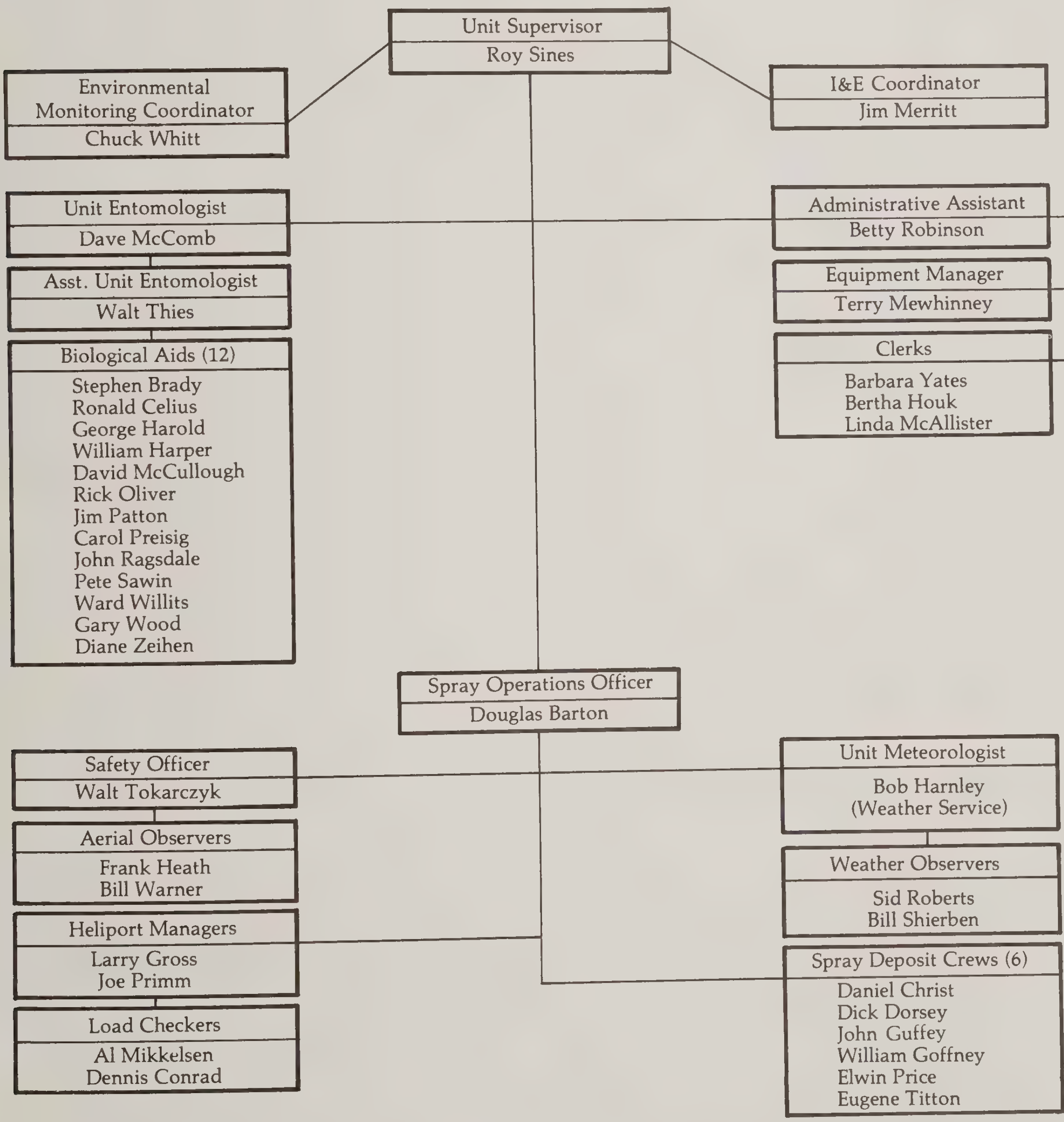


FIGURE 5

POMEROY UNIT #2
UNIT HEADQUARTERS ORGANIZATION

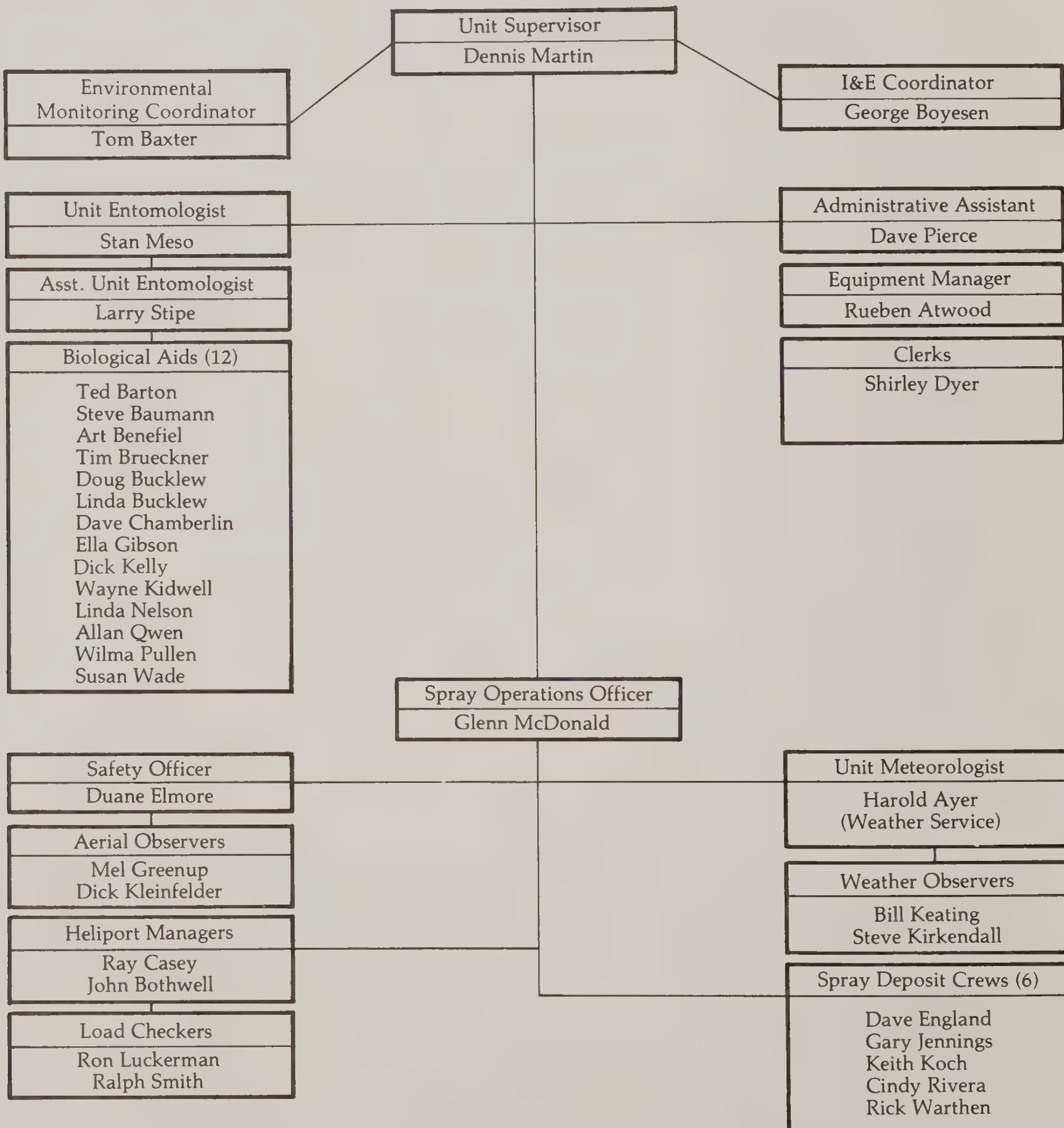


FIGURE 6

LA GRANDE UNIT #3
UNIT HEADQUARTERS ORGANIZATION

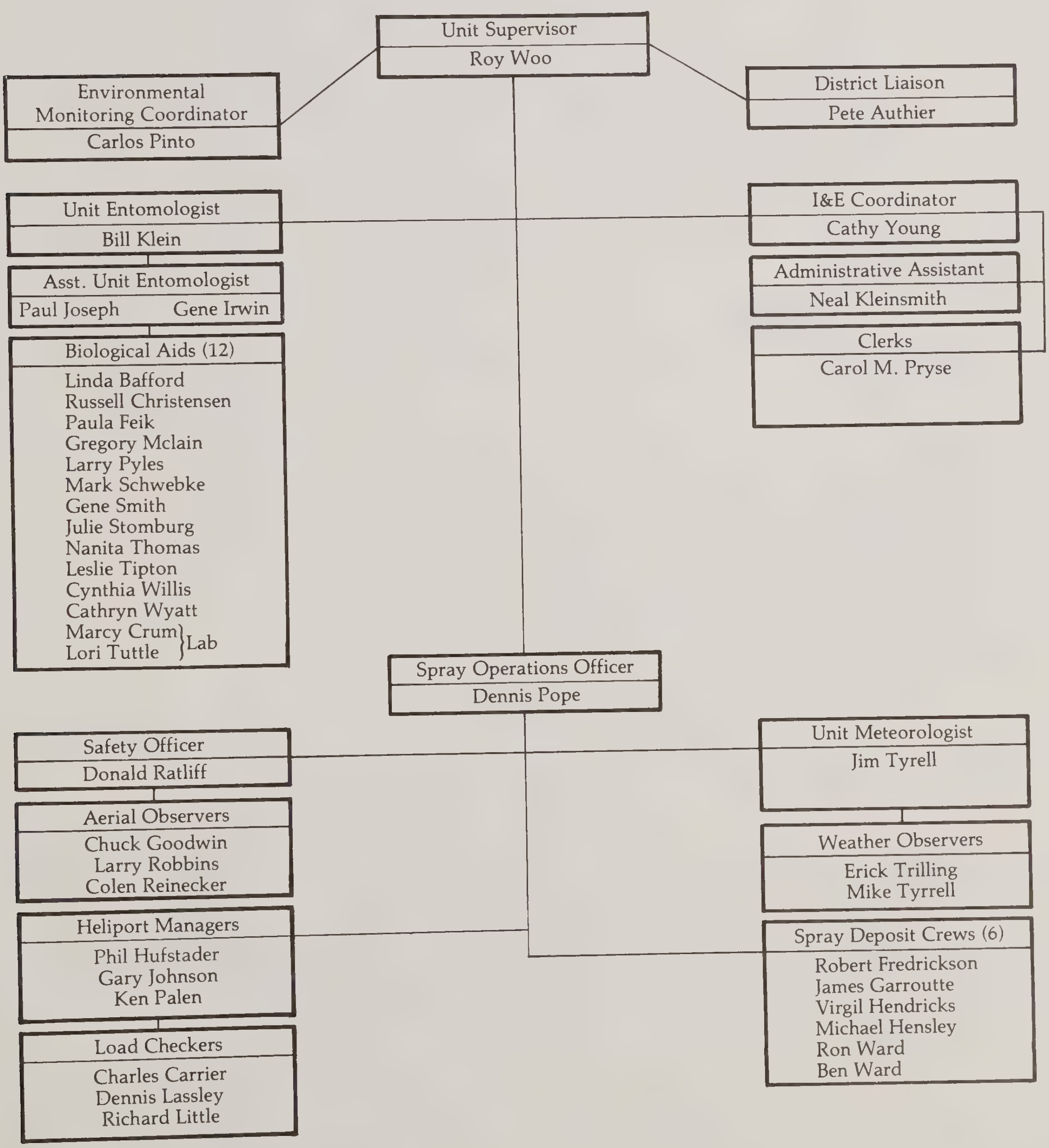


FIGURE 7

HALFWAY UNIT #4
UNIT HEADQUARTERS ORGANIZATION

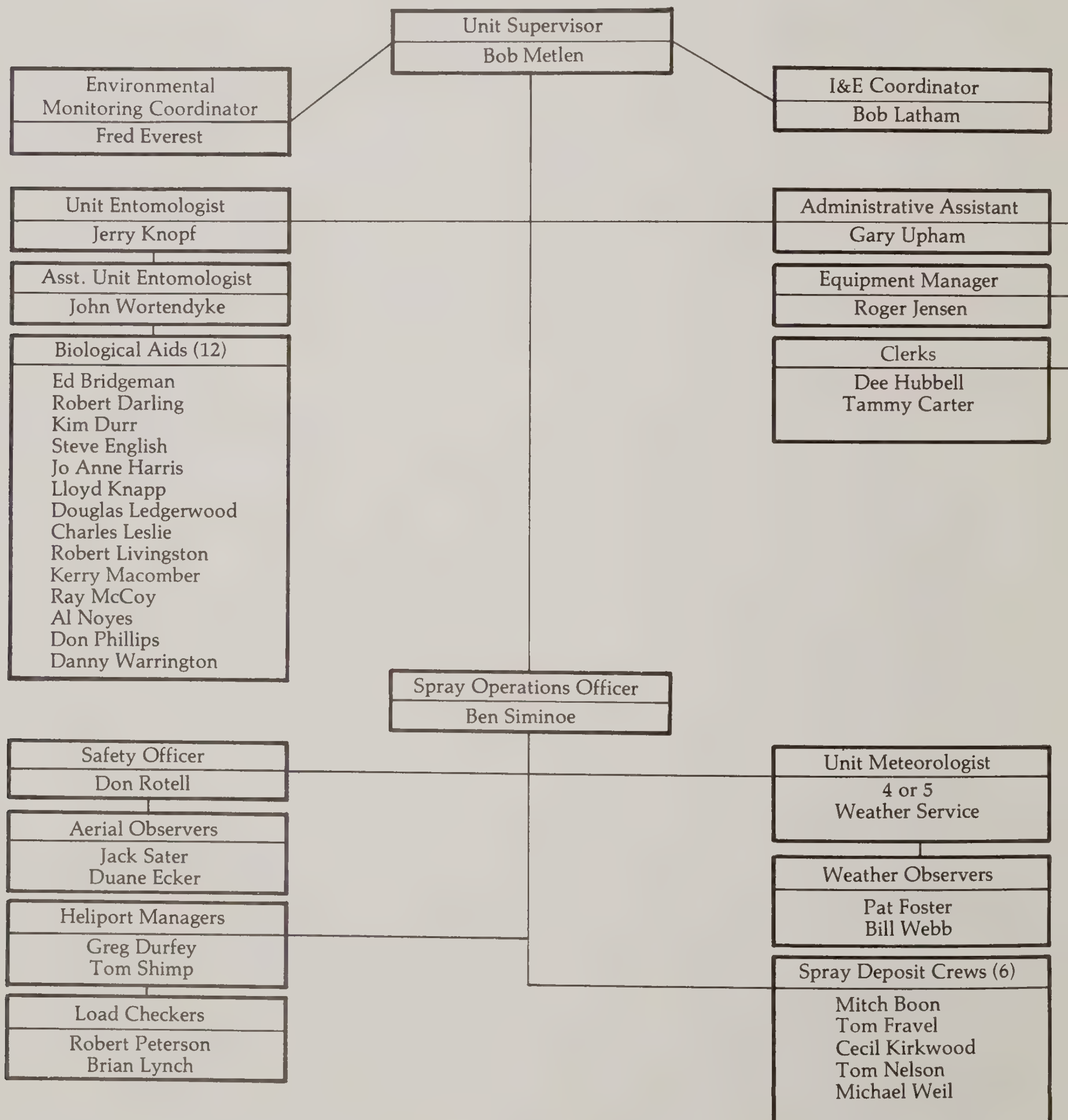


FIGURE 8

COLVILLE UNIT #5
UNIT HEADQUARTERS ORGANIZATION

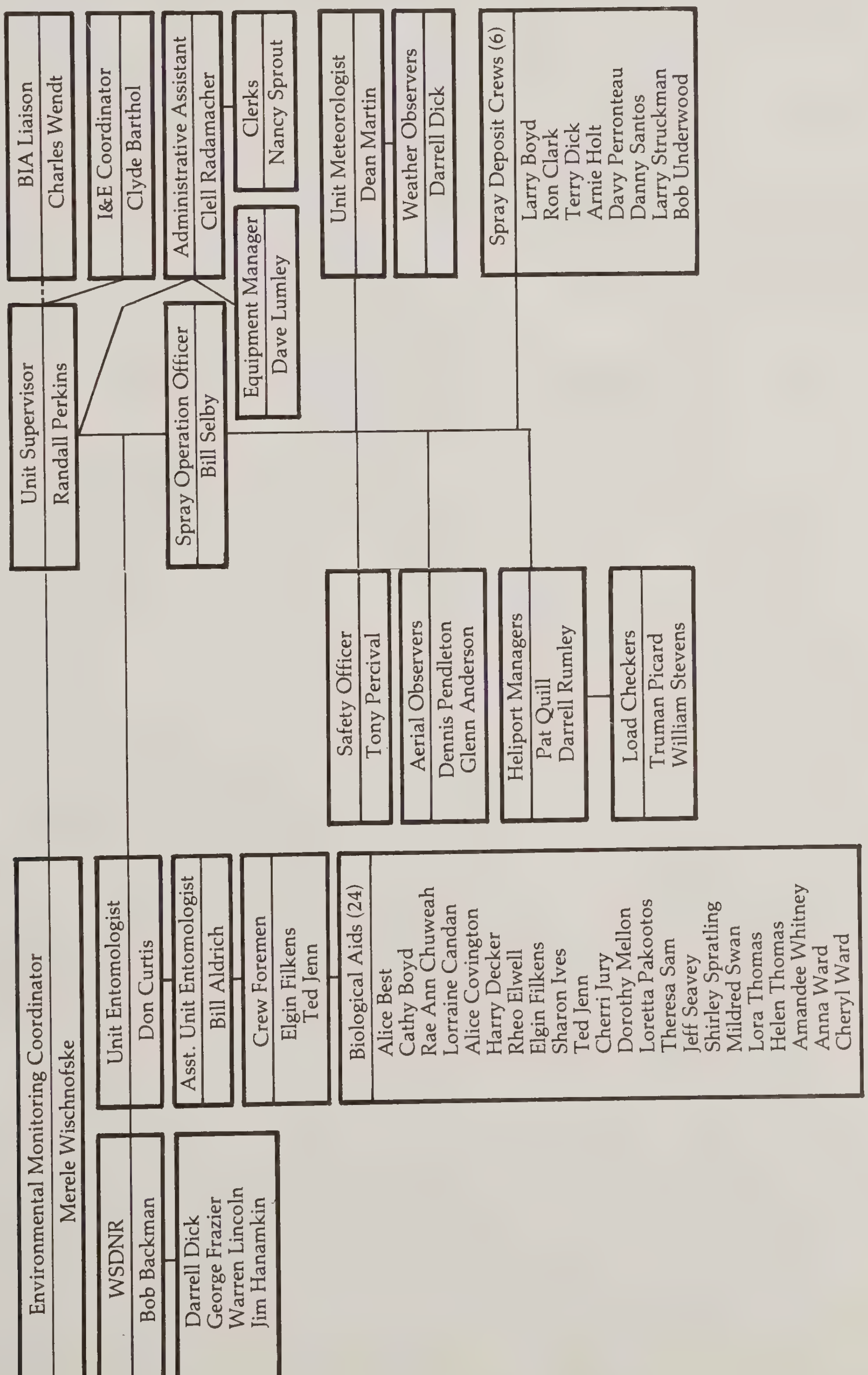


FIGURE 9

ST. JOE UNIT #6
UNIT HEADQUARTERS ORGANIZATION

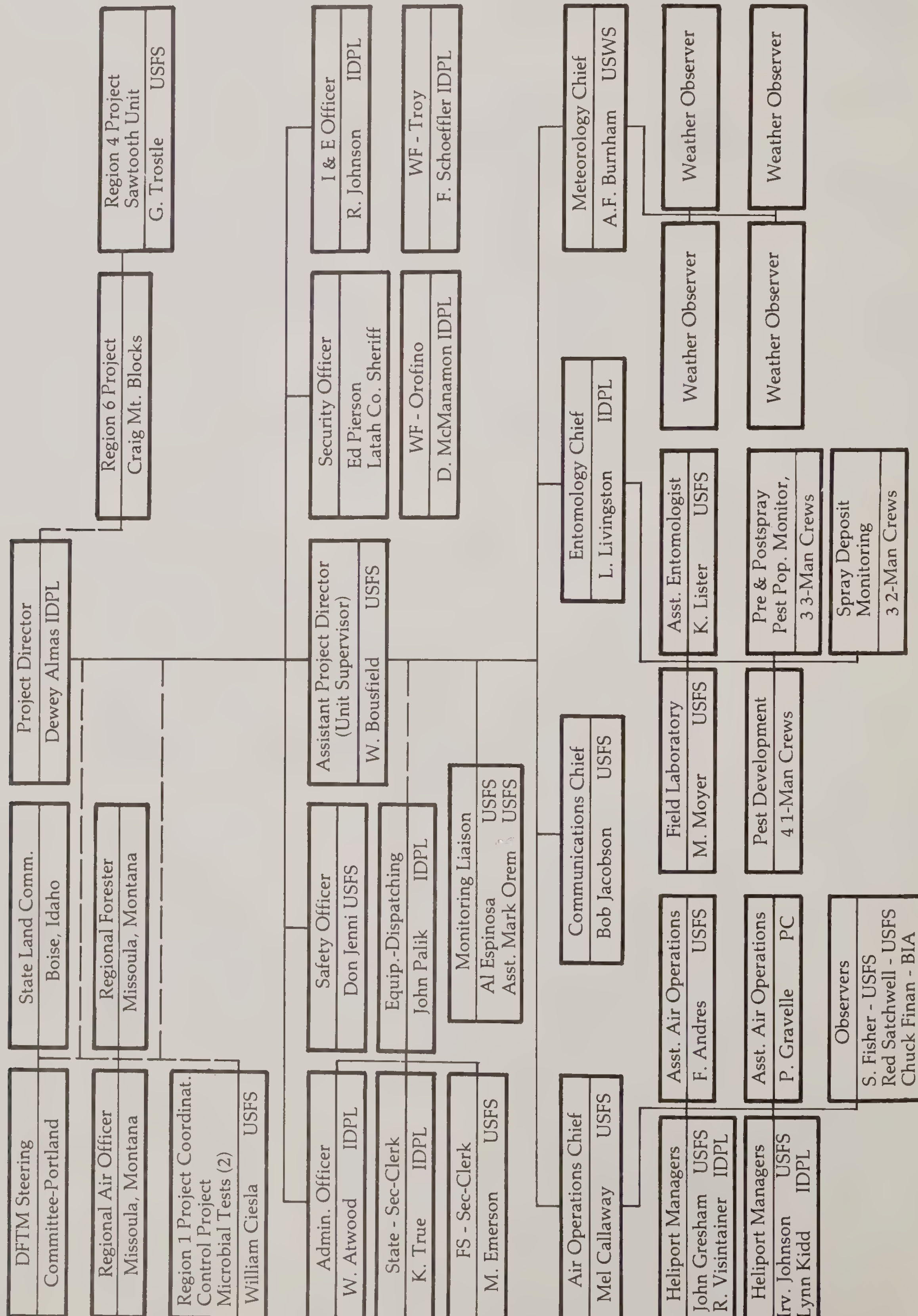


FIGURE 10

SAWTOOTH UNIT #7
UNIT HEADQUARTERS ORGANIZATION

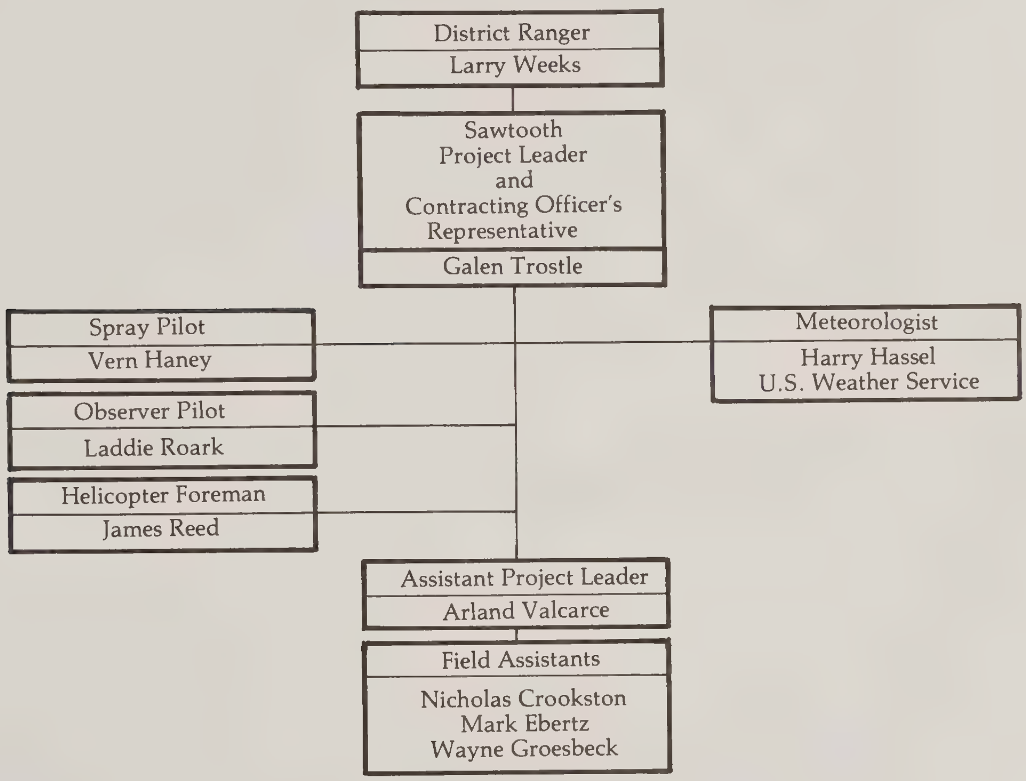


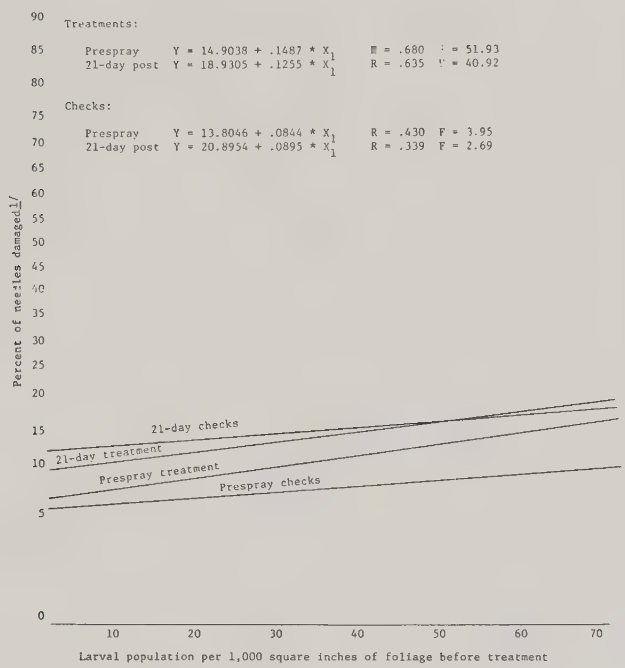
Figure 11

See Page 56

FIGURE 12

REGRESSION ANALYSIS OF NEW FOLIAGE DURING THE PERIOD BETWEEN THE PRESPRAY AND 21-DAY POSTSPRAY EVALUATION

COLVILLE UNIT

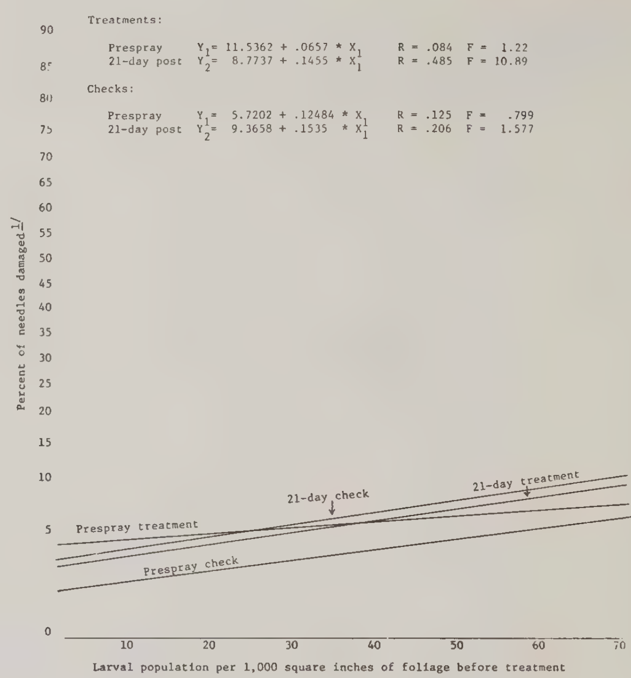


1/ Percentages in arcsin transformation format.

FIGURE 13

REGRESSION ANALYSIS OF NEW FOLIAGE DURING THE PERIOD BETWEEN THE PRESPRAY AND 21-DAY POSTSPRAY EVALUATION

POMEROY UNIT

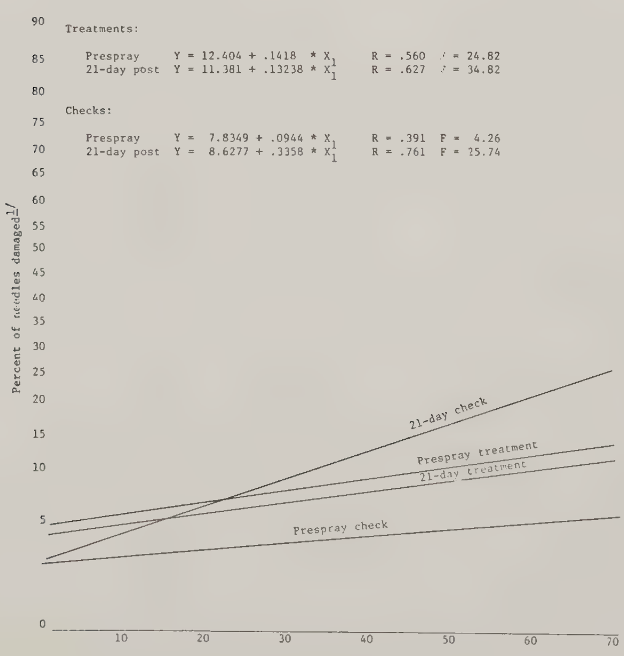


1/ Percentages in arcsin transformation format.

FIGURE 14

REGRESSION ANALYSIS OF NEW FOLIAGE DURING THE PERIOD BETWEEN THE PRESPRAY AND 21-DAY POSTSPRAY EVALUATION

HALFWAY UNIT

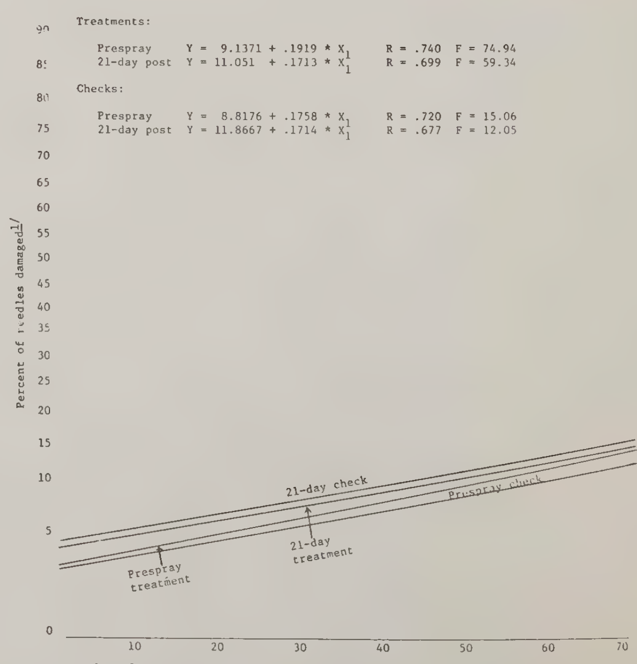


1/Percentages in arcsin transformation format.

FIGURE 15

REGRESSION ANALYSIS OF NEW FOLIAGE DURING THE PERIOD BETWEEN THE PRESPRAY AND 21-DAY POSTSPRAY EVALUATION

LAGRANDE UNIT

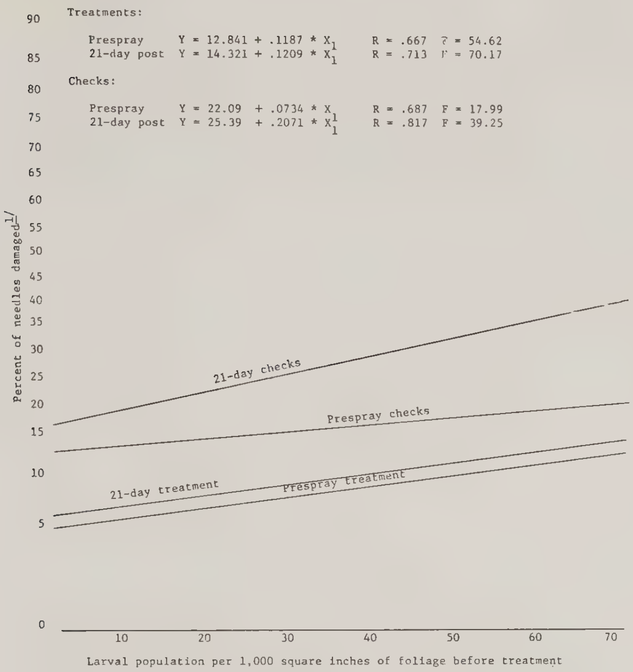


1/ Percentages in arcsin transformation format.

FIGURE 16

REGRESSION ANALYSIS OF NEW FOLIAGE DURING THE PERIOD BETWEEN THE PRESPRAY AND 21-DAY POSTSPRAY EVALUATION

WALLOWA UNIT

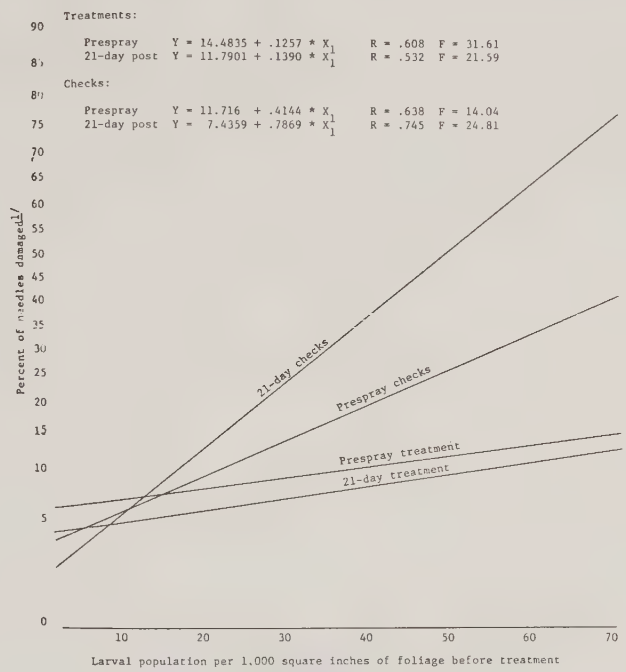


1/Percentages in arcsin transformation format.

FIGURE 17

REGRESSION ANALYSIS OF NEW FOLIAGE DURING THE PERIOD BETWEEN THE PRESPRAY AND 21-DAY POSTSPRAY EVALUATION

ST, JOE UNIT

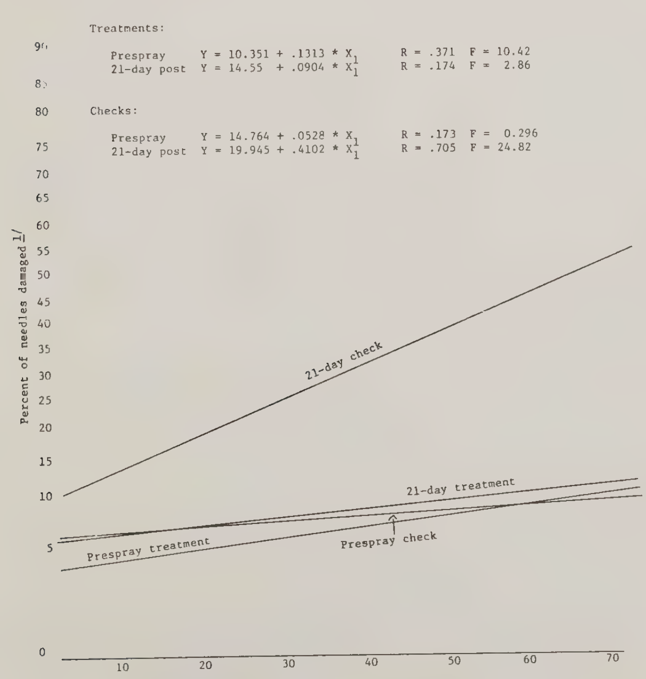


1/ Percentages in arcsin transformation format.

FIGURE 18

REGRESSION ANALYSIS OF NEW FOLIAGE DURING THE PERIOD BETWEEN THE PRESPRAY AND 21-DAY POSTSPRAY EVALUATION

SAWTOOTH UNIT



1/Percentages in arcsin transformation format.

FIGURE 19

REGRESSION ANALYSIS OF VISUAL DAMAGE NEW AND OLD GROWTH FOLIAGE EXPRESSED AS TO AN INCREASE IN DEFOLIATION INDEX

COLVILLE UNIT

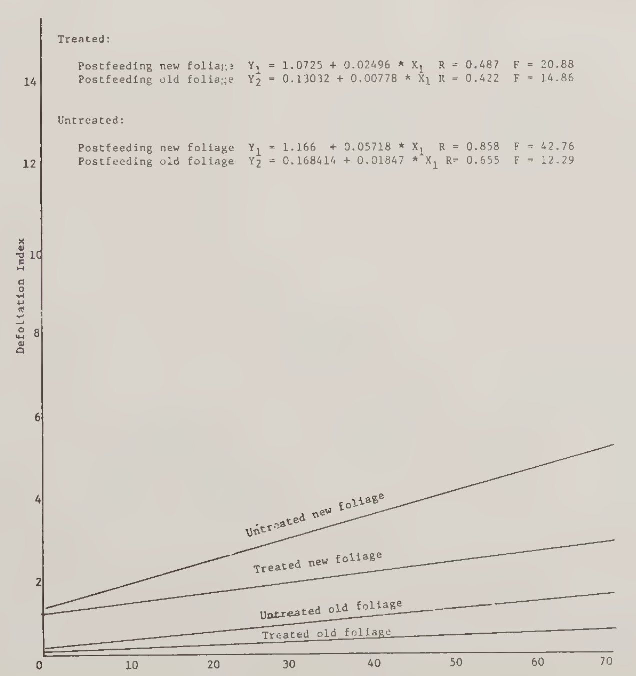


FIGURE 20

REGRESSION ANALYSIS OF VISUAL DAMAGE TO NEW AND OLD GROWTH FOLIAGE EXPRESSED AS AN INCREASED IN DEFOLIATION INDEX

POMEROY UNIT

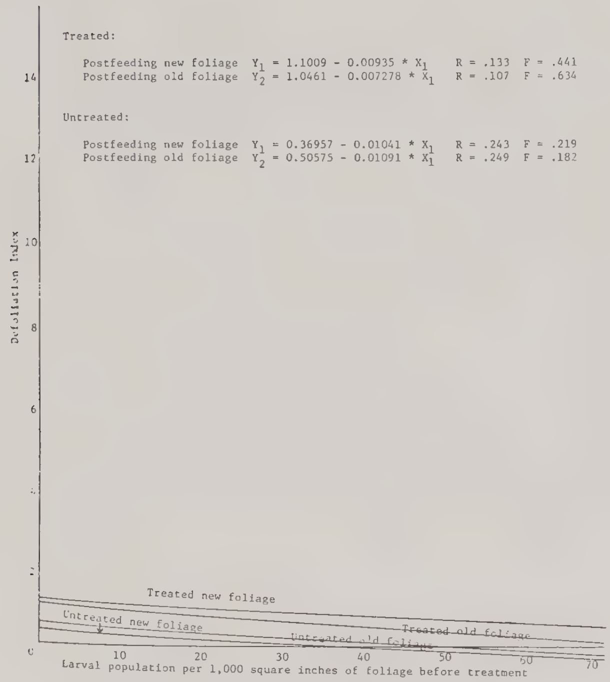


FIGURE 21

REGRESSION ANALYSIS OF VISUAL DAMAGE TO NEW AND OLD GROWTH FOLIAGE EXPRESSED AS AN INCREASE IN DEFOLIATION INDEX

HALFWAY UNIT

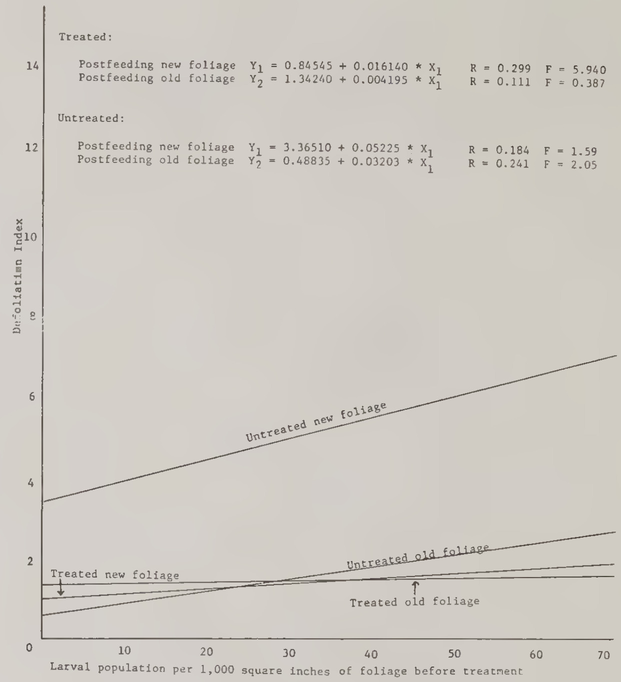


FIGURE 22

REGRESSION ANALYSIS OF VISUAL DAMAGE TO NEW AND OLD GROWTH FOLIAGE EXPRESSED AS AN INCREASE IN DEFOLIATION INDEX

LaGRANDE UNIT

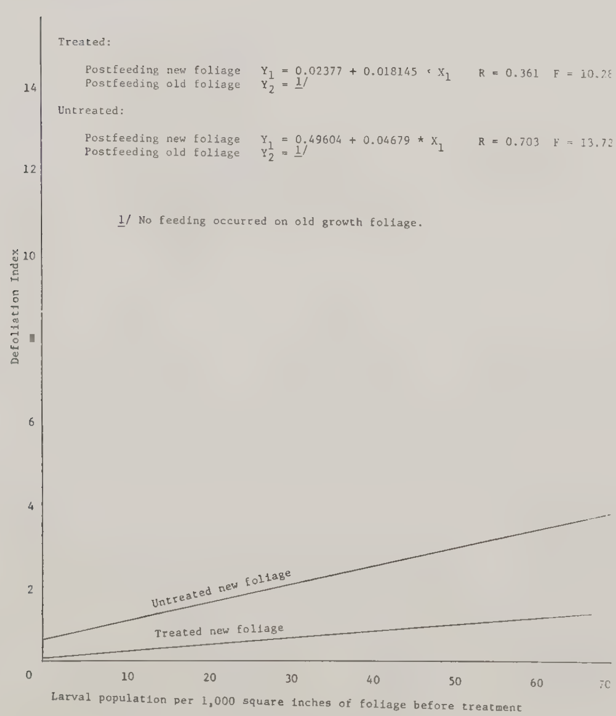


FIGURE 23

REGRESSION ANALYSIS OF VISUAL DAMAGE TO NEW AND OLD GROWTH FOLIAGE EXPRESSED AS AN INCREASE IN DEFOLIATION INDEX

WALLOWA UNIT

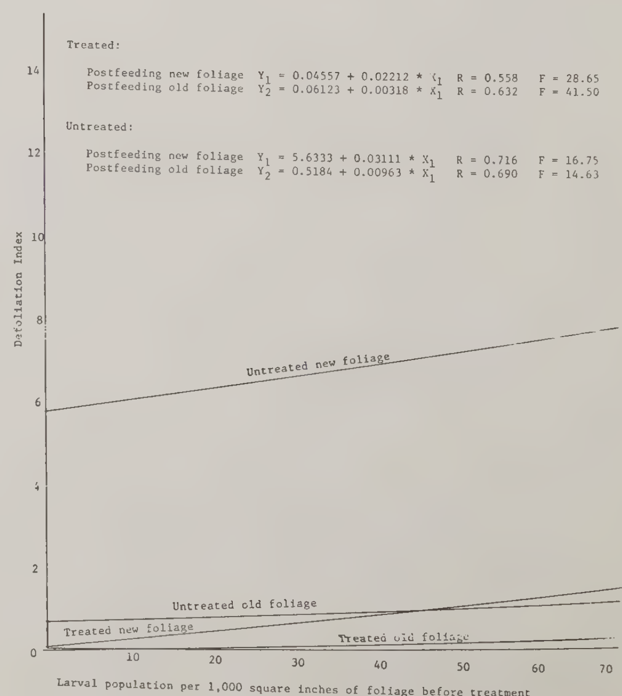


FIGURE 24

REGRESSION ANALYSIS OF VISUAL DAMAGE TO NEW AND OLD GROWTH FOLIAGE EXPRESSED AS AN INCREASE IN DEFOLIATION INDEX

ST. JOE UNIT

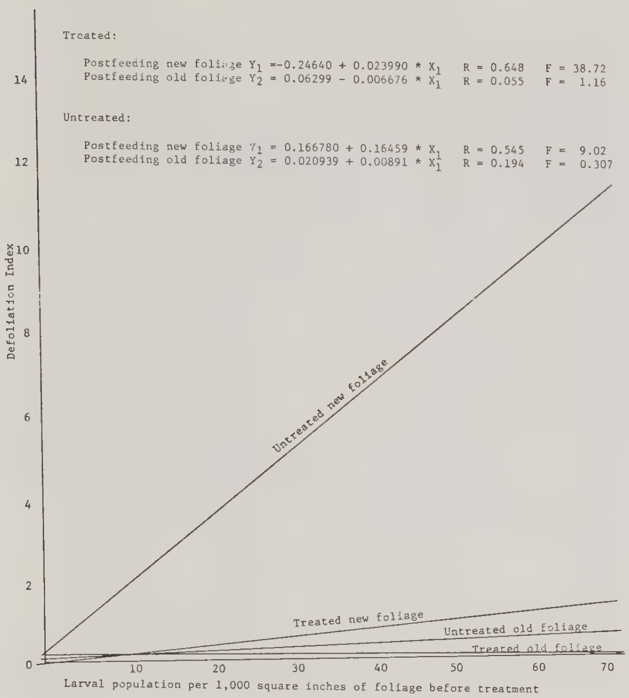


FIGURE 25

REGRESSION ANALYSIS OF VISUAL DAMAGE TO NEW AND OLD GROWTH FOLIAGE EXPRESSED AS AN INCREASE IN DEFOLIATION INDEX

SAWTHOOTH UNIT

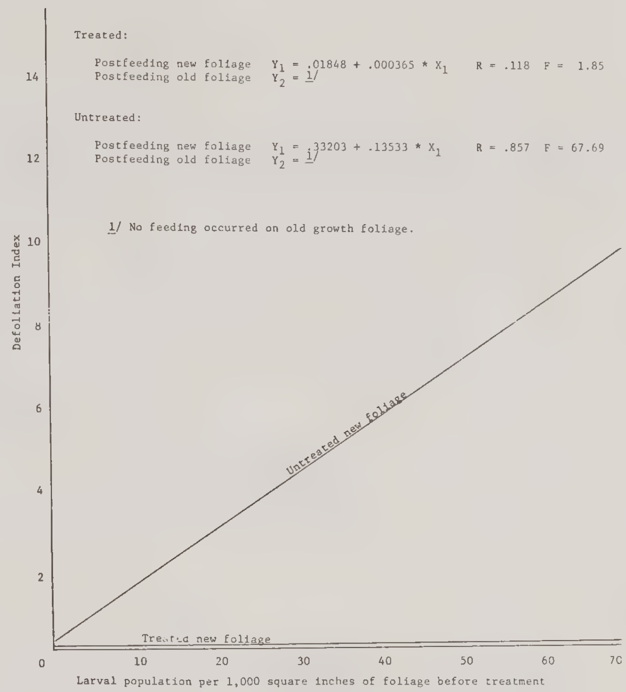


TABLE 3

Production and Flight Hours by Type of Helicopter

Control Unit	Hiller 12E		Bell 206B		Bell 205A-1		Aerospatiale Lama		Bell B-1 and G47-3B-2		Totals	
	Hrs	Acres	Hrs	Acres	Hrs	Acres	Hrs	Acres	Hrs	Acres	Hrs	Acres
Wallowa	24.7	4,775	52.3	21,750	70.1	61,892					147.1	88,417
Pomeroy	49.1	15,646							5.1	1,528	54.2	17,174
La Grande	42.8	11,491	21.9	8,257	21.1	18,303					85.8	38,051
Halfway							97.0	33,710			97.0	33,710
Colville	32.5	8,362			193.0	158,876					225.5	167,238
St. Joe					57.4	75.254					57.4	75,254
Sawtooth									11.5	1,100	11.5	1,100
Totals	149.1	40,274	74.2	30,007	341.6	314,325	97.0	33,710	16.6	2,628	678.5	420,944
Production/ Hour-Acres	270.1		404.4		920.2		347.5		158.3		620.4	
% of Total Production	9.6		7.1		74.7		8.0		0.6		100.0	

TABLE 6

DDT Treatment Summary Wallowa Unit - Oregon

Block Number	Dates Treated	Gallons Applied	Acres
DDT			
1	6/30,7/3	2,736	2,793
2	6/30,7/2	4,348	4,045
3	7/2-3	2,931	3,558
4	7/2	1,400	1,557
8	6/21	6,252	6,068
9	6/28,7/3	4,712	5,502
10	6/29-30	3,440	3,481
11	6/19	3,101	3,401
12	6/25	1,072	1,072
13	6/25-27	2,151	2,866
14	6/26-27	3,801	4,079
15	6/27-28	2,234	2,234
16	6/26	2,275	2,145
17	6/27-29	5,426	5,547
18	6/28-29	4,853	4,615
19	6/29-30	3,560	3,357
20	6/20	5,065	5,036
21	6/25-26	5,175	5,122
22	6/28	1,998	1,997
23	6/22	2,748	2,748
24	6/22-24	3,490	3,406
25	6/23-24	3,210	3,477
26	6/24-25	1,900	1,811
Subtotals		77,878	79,917
27 Red	7/16	1,354	1,300
28 Red	7/17	1,700	1,700
29 Red	7/17-18	1,215	1,200
30 Red	7/18-19	1,500	1,200
31 Red	7/21	1,500	1,000
32 Red	7/19-20	1,200	1,200
33 Red	7/19-20	1,000	900
Subtotals		9,469	8,500
Grand Totals DDT		87,347	88,417

TABLE 7

DDT Treatment Summary Pomeroy Unit - Washington

Block Number	Dates Treated	Gallons Applied	Acres
1A	6/22	2,275	2,474
1B	6/20-21	1,943	2,040
2A	6/20	935	935
2B	6/23-24	2,760	2,933
7A	6/29-30	2,258	2,474
7B	6/25,27-30	3,168	3,290
7C	6/25,27-30 7/1-2	3,098	3,028
Grand totals		16,437	17,174

TABLE 8			
DDT Treatment Summary La Grande Unit - Oregon			
Block Number	Dates Treated	Gallons Applied	Acres
A-3	6/26-27	1,500	1,746
A-4	6/23	748	748
A-5	6/23-24	1,500	1,588
A-6	6/25-26	1,300	1,685
A-7	6/25	750	668
A-8	6/23	1,352	1,438
A-9	6/24-25	3,050	3,451
A-10	6/24	1,800	2,003
A-11	6/27	1,200	1,601
A-12	6/21-22	1,296	1,295
B-2	6/27-28	780	586
B-3	7/3-4	701	459
B-4	7/4	870	817
B-5	6/2-3	790	942
B-6	7/4	765	583
B-7	6/28,7/1	340	360
B-8	6/24	406	389
B-9	6/24	147	147
B-10	7/2	160	234
B-11	7/3	1,350	1,196
B-12	6/24	495	548
B-13	6/22	330	353
B-14	6/23	990	1,062
B-15	7/3-4	1,050	1,012
B-16	6/22-23	1,418	1,708
B-17	6/25-27	380	428
B-23	6/24-25	2,037	2,330
Subtotals		27,505	29,377
Red-1	7/25	340	212
Red-2	7/25	105	52
Red-3	7/21-22,24	2,620	2,498
Red-4	7/24,7/28	685	905
Red-5,6,16-	7/22	700	995
Red-8-11	7/23-24	1,100	1,110
Red-12-14	7/24	1,600	1,770
Red-19	7/25	900	1,132
Subtotals		8,050	8,674
Grand Totals		35,555	38,051

TABLE 9			
DDT Treatment Summary Halfway Unit - Oregon			
Block Number	Dates Treated	Gallons Applied	Acres
1	6/25	830	865
2	6/25	660	590
3	6/25	661	855
4	6/25	770	1,000
6	6/23	316	420
7	7/13	1,226	1,240
8	6/23	985	745
9	6/23	630	900
10	6/23-24	1,243	1,560
11	6/24	730	730
12	6/21	890	1,200
13	6/20	1,400	1,375
14	7/15	1,440	2,120
15	6/30	520	555
16	6/30	810	1,175
17	7/4	435	600
18	6/30,7/4	1,288	1,120
19	6/23	701	585
20	6/19	736	1,030
21	7/4	1,081	1,325
22	6/22	345	855
23	6/21-22	1,146	1,200
24	7/14	1,080	1,095
25	7/5	710	825
26	6/22	1,473	1,365
27	7/5	180	160
28	7/17	499	480
29	7/17	261	240
40	6/27	1,600	1,575
41	7/3,5	1,043	1,290
42	6/28,7/3	771	775
43	7/3	1,160	1,440
44A	7/16	530	520
44B	7/16	530	520
45	7/5,6	559	860
46	6/26	1,390	790
48	7/7-8	1,292	1,200
50	7/7-8	1,490	1,260
52A	6/26	387	360
52B	6/26	560	480
53	6/26	1,205	1,190
55	6/18	600	570
56	6/18	150	285
Grand Totals		36,313	39,325

TABLE 10

DDT Treatment Summary
Colville Unit - Washington

Block Name and Number	Dates Treated	Gallons Applied	Acres
CP-1	6/21-22	2,460	3,184
CP-2	6/18,20,21	1,469	1,955
CP-3	6/18-19	1,531	2,039
CP-4	6/23	2,850	2,125
Cody Butte	6/25-26	3,560	3,430
GM-1	6/21-25	14,120	12,849
GM-2	6/22	1,500	2,304
GM-3	6/21-22	7,300	8,554
GM-4	6/21	5,500	5,074
Great Western	6/17	150	128
Hunters-1	6/15	70	
Hunters-2	6/15	1,000	
Hunters-3	6/15	800	
Hunters-4	6/17	3,000	
Hunters-5	6/18	900	
Hunters-6	6/18	900	8,139
Hunters-7	6/18	500	
Hunters-8	6/18	900	
Hunters-9	6/19	2,300	
Keller-1	6/16-17,23,24	4,800	4,674
Keller-2,3	6/24	7,300	7,626
Keller-4	6/23	560	566
Manilo Creek	6/22-23	1,470	1,232
Nicholls-1	6/12	750	
Nicholls-2	6/9	300	
Nicholls-3	6/9	1,350	2,235
Nicholls-4	6/9	600	
North Nanamkin	6/26	6,100	5,166
Shamrock	6/24-26	15,900	13,705
Whitestone-1	6/9,18,19	8,400	9,783
Whitestone-2	6/17-20	6,500	3,480
Whitestone-3	6/19,14-15,17-1	6,300	4,419
Whitestone-4	6/19-20	11,150	10,461
Subtotals		122,290	113,128
Red Areas			
Cody Red (R-1)	6/27,29	9,900	
Gold Lake (R-2)	6/29	2,100	
Gold Mtn. (R-3)	7/1-2	7,790	
Hunters-6 (R-4)	6/27	300	
Johnny George (R-5)	6/27	600	
Keller (R-6)	6/30-7/1	6,100	
Nicholls Mtn. (R-7)	6/27	600	
Nanamkin (R-8)	6/28-30	11,500	
Rice (R-9)	7/2	162	
Shamrod (R-10)	6/30	2,550	
30 Mile (R-11)	6/28-30	8,650	
Whitestone (R-12)	7/2	3,479	(from survey)
Subtotals		53,731	54,110
Grand Totals		176,021	167,238

TABLE 11

DDT Treatment Summary
St. Joe Unit - Idaho

Block Number	Dates Treated	Gallons Applied	Acres
1	Added to 27 & 28........		860
2	6/28,6/30		3,600
3	6/28,6/29		2,700
4	6/30		1,800
5	6/21,6/22		1,500
6	6/30,7/6		1,200
7	6/22		1,600
8	6/23		2,200
9	6/23,6/24		2,550
10	6/24		1,750
12	6/25		1,700
13	6/25		1,300
14	6/24,6/25		1,600
15	6/25,6/27		2,600
16	6/21		3,700
17	7/2		2,100
18	7/2		2,100
19	6/30,7/6		4,200
20	6/27		2,100
21	7/3		1,200
23	7/3,7/5		1,850
24	7/3		2,700 1/
25	7/6		2,100
26	7/3,7/6		4,250 2/
27	7/4,7/6		4,350 3/
28	7/6		2,640
29	7/7		1,250
30	7/7		1,550
31	7/7		2,900
32	6/19		1,975
33	6/20		3,350
34			
35	7/7,7/8		3,979
Grand Totals		75,254	75,254

1/ Includes 800 acres of "red top" areas.
2/ Includes 2,000 acres of "red top" areas.
3/ Includes 400 acres of "red top" areas.

TABLE 12

DDT Treatment Summary Sawtooth Unit - Idaho

Block Number	Dates Treated	Gallons Applied	Acres
A			428
B	6/17-21		411
C			261
Grand Totals		985	1,100

TABLE 13

Daily Record of DDT Spraying in Idaho, Oregon, and Washington

Date	Acres	Date	Acres
6/9	1,650	7/2	19,821
6/12	3,000	7/3	13,166
6/14	2,100	7/4	7,287
6/15	2,870	7/5	5,485
6/16	2,100	7/6	5,460
6/17	5,190	7/7	7,591
6/18	9,620	7/8	4,870
6/19	18,322	7/13	1,226
6/20	24,100	7/14	1,080
6/21	28,783	7/15	1,440
6/22	19,901	7/16	1,884
6/23	25,260	7/17	3,230
6/24	30,184	7/18	1,045
6/25	30,697	7/19	1,700
6/26	24,046	7/20	1,400
6/27	20,394	7/21	2,565
6/28	23,341	7/22	1,410
6/29	25,176	7/23	1,100
6/30	27,586	7/24	2,860
7/1	10,389	7/25	1,615

78% of the spraying was done during a 2 week period, 6/19 - 7/2. Average acreage treated per-day was 10,523. It required 40 spray days to treat the 420,944 acres.

TABLE 14

Production and Flight Hours of Helicopters by Control Units

Control Unit	Total Acreage Sprayed DDT	Total Days Available From Starting Day	Spray Days Available	Average Production Per Day Available	Average Production Per Spray Day	Average Production Per Flight Hour	Total Flight Hours For Spray Helicopters	Total Flight Hours For Observation Helicopters
Wallowa (1)	88,417	33	20	2,679	4,420	613	147.1	315.8
La Grande (3)	38,051	35	17	1,087	2,238	397	85.8	230.6
Halfway (4)	33,710	30	23	1,124	1,466	348	97.0	490.3
Pomeroy (2)	17,174	13	12	1,321	1,431	317	54.2	372.4
Colville (5)	167,238	24	21	6,968	7,963	781	225.5	478.8
St. Joe (6)	75,254	20	20	3,762	3,762	1,311	57.4	127.7
Sawtooth (7)	1,100	5	5	220	220	96	11.5	9.7
Totals	420,944	160	118	2,631	3,567	620	678.5	2,241.4 1/

1/ Includes 216.1 hours of time on Administrative Helicopter at Walla Walla Spray Headquarters.

TABLE 15

Project Cost Summary

	Northern Oregon and Washington	Southern Idaho St. Joe Unit	Total Idaho Sawtooth Unit	Chargeable to Project	Cost per Acre	Contributed Monitoring by State Agencies2/	Contributed Salaries of Permanent F.S. Personnel	Contributed of State Personnel	Contributed by B.I.A.	Contributed by B.L.M.	Total
Insecticide	103,756	20,304	366	124,426	.30						124,426
Insecticide: Mixing, Storage, and Transportation	284,986	58,321	1,107	344,414	.82						344,414
Application	588,042	160,238	2,642	750,922	1.78						750,922
Observation and 1/ Administrative Aircraft	492,595	35,713	2,225	530,533	1.26						530,533
Salaries—F.S. 3/ Personnel	454,5823/	34,8784/	5,111	494,571	1.17		242,330	7.500	22,103	4,945	771,449
Vehicle Use and Travel—F.S.	150,209	11,203	3,477	164,889	.39						164,889
Supplies, materials freight, etc.	89,115	4,017	30	93,162	.22						93,162
Rents, communications and utilities	19,732	3,261		22,993	.06						22,993
State personnel, Equipment, and Miscellaneous	112,031	107,742		219,773	.52						219,773
Environmental Monitoring	168,763	67,0005/		235,763	.56	246,579			3,468		485,810
Total	2,463,811	502,677	14,958	2,981,446	7.08	246,579	242,330	7,500	25,571	4,945	3,508,371
Acres Sprayed	344,590	75,254	1,100	420,944		420,944	420,944	420,944	420,944	420,944	420,944
Cost per Acre	7.15	6.68	13.60	7.08	7.08	.59	.57	.02	.06	.01	8.33

1/ Includes some fixed wing transportation costs.

2/ Includes $150,000 from Pacific Northwest Regional Commission for environmental monitoring effort.

3/ Includes $61,412 of B.I.A. expenditures.

4/ Includes $6,616 of BIA Expenditures.

5/ Total monitoring costs in Idaho. No breakdown is available at time of preparation.

TABLE 18

Douglas-Fir Tussock Moth Survival Ratios for Each Control Unit

Control Unit		4-day postspray evaluation				21-day postspray evaluation			
		Mean survival ratio		Degrees of freedom	Student's T-ratio	Mean survival ratio		Degrees of freedom	Student's T-ratio
Colville —	treated	0.0489	0.0296 1/	72	3.369**	0.0094	0.0054	72	7.04***
	untreated	1.1330	0.6692			0.3048	0.0854		
Pomeroy —	treated	0.0159	0.0122	45	3.720***	0.00739	0.0058	45	2.58**
	untreated	0.2660	0.1010			0.2404	0.1403		
Halfway —	treated	0.0136	0.0055	70	11.210***	0.0064	0.0055	70	7.01***
	untreated	0.8569	0.1260			0.3219	0.0742		
La Grande —	treated	0.0339	0.0170	74	5.180***	0.00713	0.0070	74	2.58**
	untreated	0.5122	0.1829			0.1662	0.1288		
Wallowa —	treated	0.0178	0.0093	86	9.310***	0.1490	0.0141	86	5.75***
	untreated	0.4422	0.0788			0.2733	0.0682		
St. Joe —	treated	0.00784	0.0074	71	10.660***	0.000876	0.0009	71	6.47***
	untreated	0.7868	0.1186			0.3984	0.1011		
Sawtooth —	treated	0.0652	0.0228	83	3.430***	0.0696	0.0295	83	3.68***
	untreated	0.3656	0.1251			0.3646	0.1026		

1/ One standard error.

* 10 percent significance
** 5 percent significance
*** 1 percent significance

TABLE 19

Covariance Analysis of Regression Lines Obtained From Measuring Damaged Needles at Prespray and 21-day Postspray intervals

Control Unit	Regressions tested	Test for differences in slope: Regression coefficient	Degrees of freedom	F	Test for differences in elevation: Adjusted means (arcsin transformation)	Degrees of freedom	F
Colville	Prespray treatment	0.1487	1/116	0.666 NS	24.88	1/118	0.911 NS
a/	21-day treatment	.1255			27.35		
	Prespray check	.0845	1/ 70	.920 NS	20.53	1/ 71	.699 NS
b/	Prespray treatment	.1487			23.97		
	Prespray check	.0843	1/ 24	.000 NS	16.64	1/ 25	3.569*
c/	21-day check	.0859			23.79		
	21-day check	.0859	1/ 70	.365 NS	27.09	1/ 71	.061 NS
d/	21-day treatment	.1255			26.58		
Pomeroy	Prespray treatment	.0656	1/ 60	1.640 NS	12.95	1/ 63	.397 NS
	21-day treatment	.1454			11.91		
	Prespray check	.1248	1/ 43	.066 NS	7.22	1/ 44	5.539**
	Prespray treatment	.0656			12.63		
	Prespray check	.1248	1/ 24	.024 NS	6.47	1/ 25	6.617**
	21-day check	.1543			10.29		
	21-day check	.1535	1/ 43	.002 NS	11.88	1/ 44	.138 NS
	21-day treatment	.1454			11.23		
Halfway	Prespray treatment	.1418	1/102	.067 NS	15.26	1/103	1.030 NS
	21-day treatment	.1323			14.05		
	Prespray check	.0943	1/ 68	.0323 NS	9.56	1/ 69	10.220***
	Prespray treatment	.3358			14.86		
	Prespray check	.0943	1/ 34	8.990***	9.22	1/ 35	7.400**
	21-day check	.3358			13.58		
	21-day check	.3358	1/ 68	8.000***	13.96	1/ 69	.0549 NS
	21-day treatment	.1323			14.82		

NS—Nonsignificant
* 10 percent level
** 5 percent level
*** 1 percent level

a/ Test to determine if treatment failed to stop continued feeding. (Should be NS)

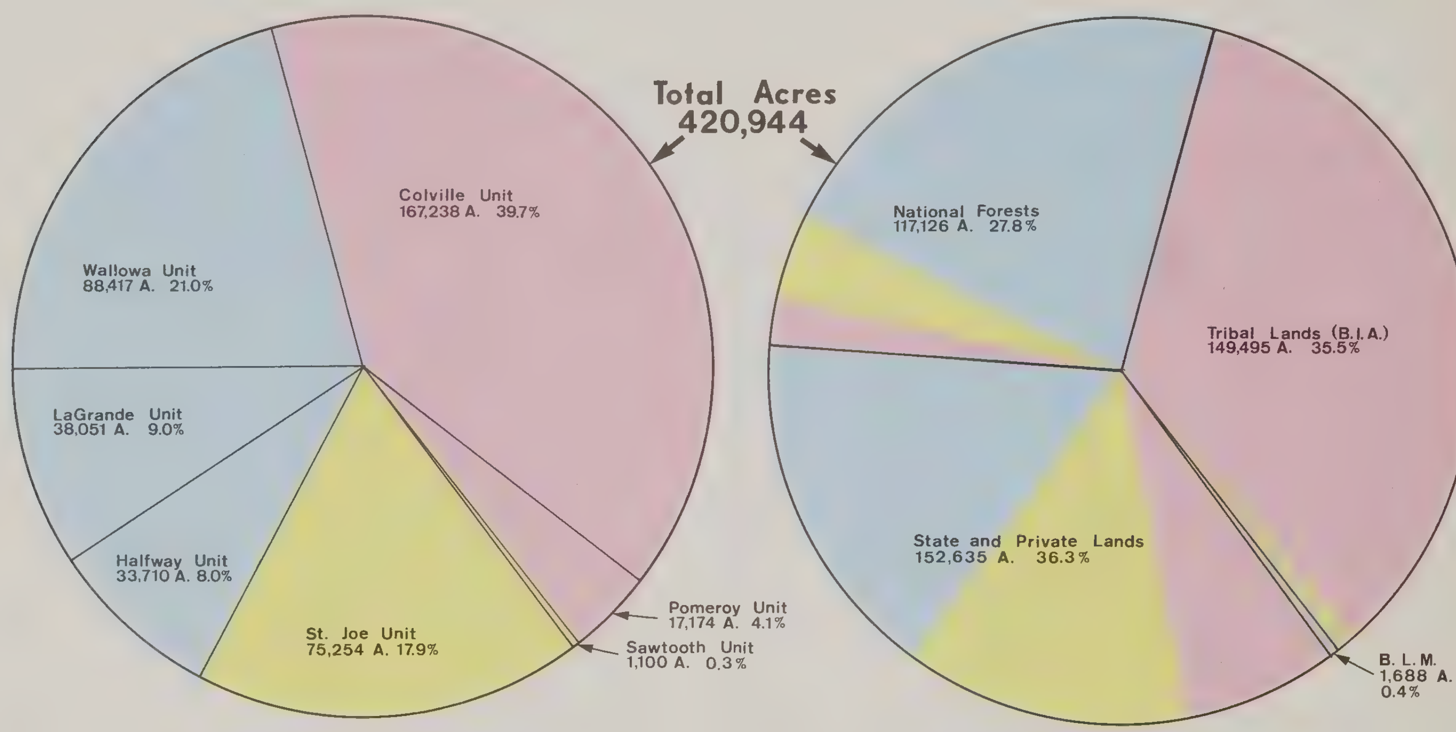
b/ Test to determine if feeding was more advanced in either check or treatment area prior to spray application. (Should be NS)

c/ Test to determine if feeding progressed in untreated check areas. (Should be significant)

d/ Test to determine if untreated is different from treated after 21 days of feeding. (Should be significant)

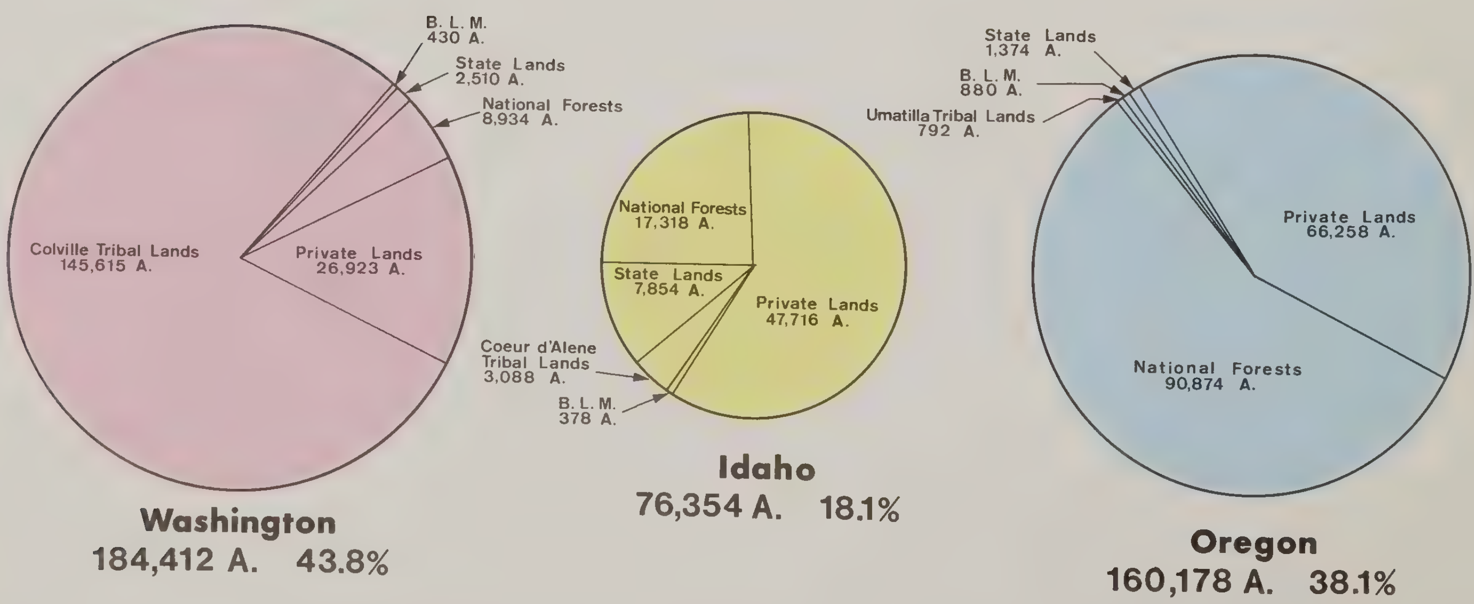
TABLE 19, continued							
		Test for differences in slope			Test for differences in elevation		
Control Unit	Regressions tested	Regression coefficient	Degrees of freedom	F	Adjusted means (arcsin transformation)	Degrees of freedom	F
La Grande	Prespray treatment 21-day treatment	0.1919 .1713	1/120	0.666 NS	14.05 15.43	1/121	2.470 NS
	Prespray check Prespray treatment	.1758 .1919	1/ 72	.110 NS	13.30 14.02	1/ 73	.242 NS
	Prespray check 21-day check	.1758 .1714	1/ 24	.004 NS	13.14 16.07	1/ 25	2.087 NS
	21-day check 21-day treatment	.1714 .1718	1/ 72	.000 NS	16.22 15.41	1/ 73	.300 NS
Wallowa	Prespray treatment 21-day treatment	.1187 .1209	1/132	.011 NS	17.57 19.14	1/113	1.106 NS
	Prespray check Prespray treatment	.0733 .1187	1/ 84	2.900*	24.75 16.08	1/ 85	7.350***
	Prespray check 21-day check	.0733 .2071	1/ 36	12.840***	27.91 41.81	1/ 37	12.550***
	21-day check 21-day treatment	.2071 .1209	1/ 84	8.860***	37.22 15.19	1/ 85	40.830***
St. Joe	Prespray treatment 21-day treatment	.1256 .1390	1/103	.127 NS	18.02 15.71	1/104	2.740 NS
	Prespray check Prespray treatment	.4141 .1256	1/ 69	2.840*	17.80 17.40	1/ 70	.069 NS
	Prespray check 21-day check	.4141 .7869	1/ 36	3.730*	16.16 15.71	1/ 37	.037 NS
	21-day check 21-day treatment	.7869 .1390	1/ 69	7.956***	17.75 15.00	1/ 70	1.671 NS
Sawtooth	Prespray treatment 21-day treatment	.1313 .0903	1/116	.371 NS	11.67 15.35	1/117	12.660***
	Prespray check Prespray treatment	.0528 .1313	1/ 81	.732 NS	15.35 11.61	1/ 82	7.960***
	Prespray check 21-day check	.0528 .4102	1/ 46	7.870**	15.18 23.22	1/ 47	17.760**
	21-day check 21-day treatment	.4102 .0903	1/ 81	9.340***	23.47 15.36	1/ 82	25.910***

CHARTS OF ACREAGES AND OWNERSHIPS



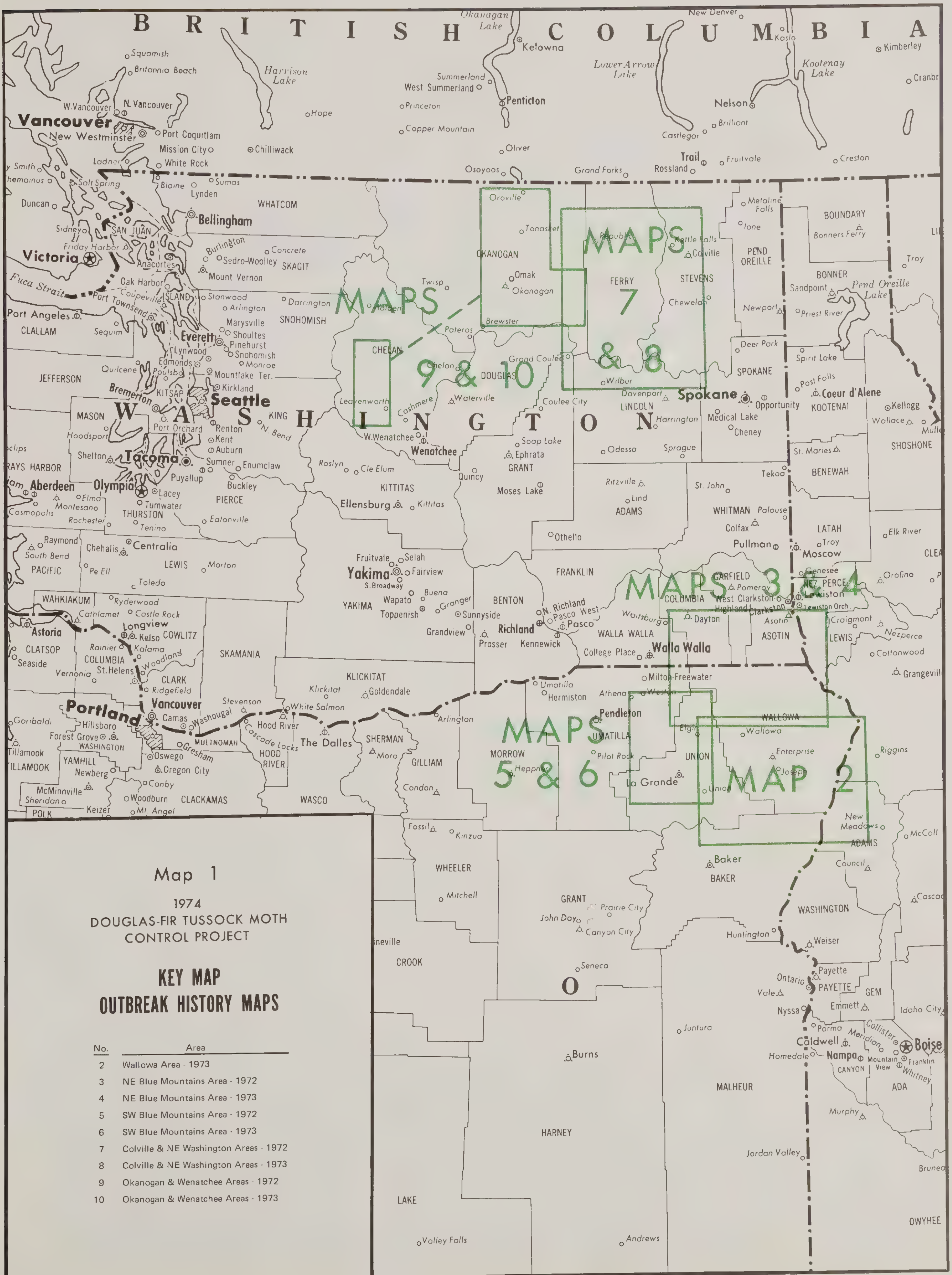
ACRES SPRAYED BY CONTROL UNIT

ACRES SPRAYED BY OWNERSHIP

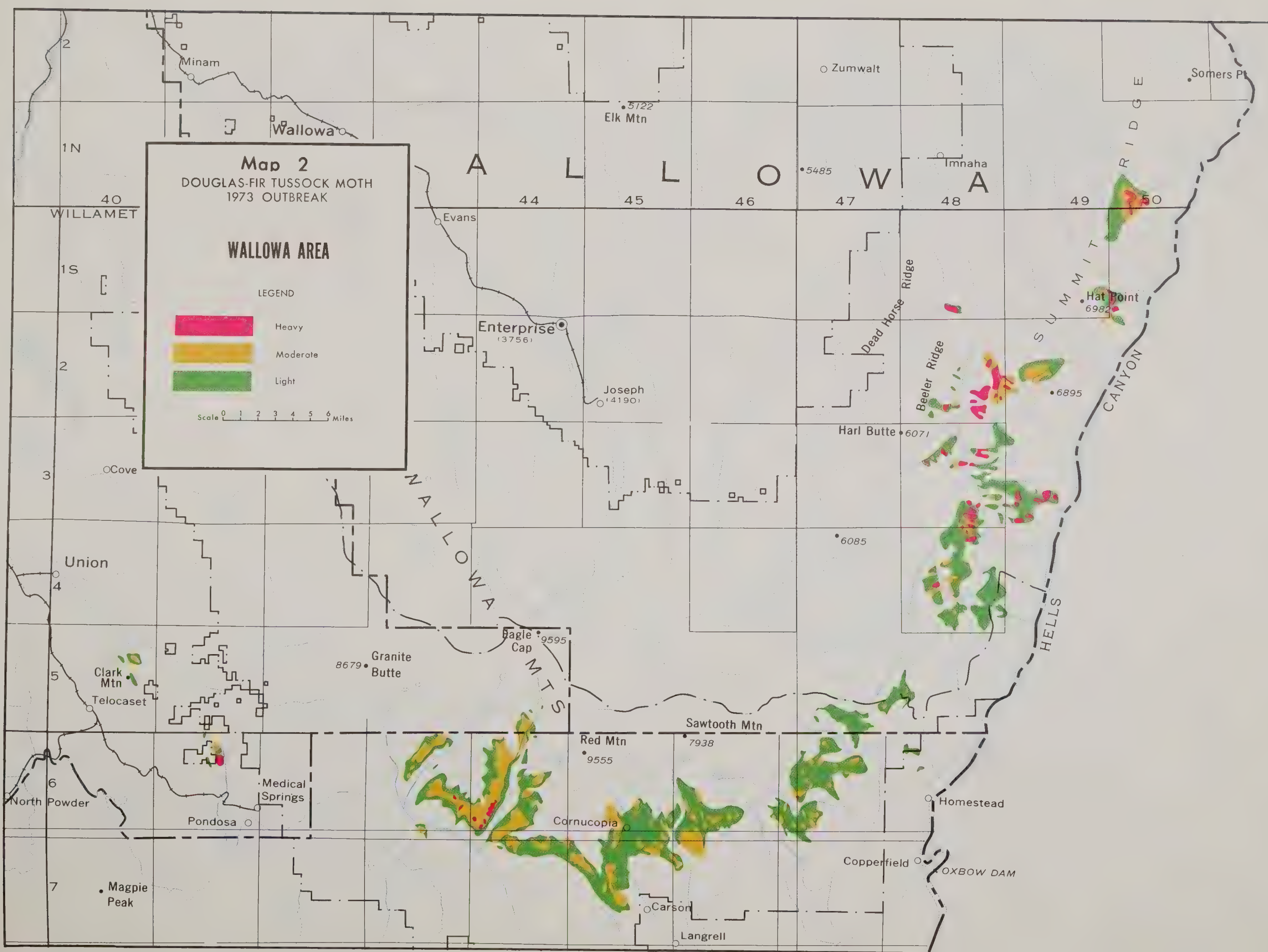


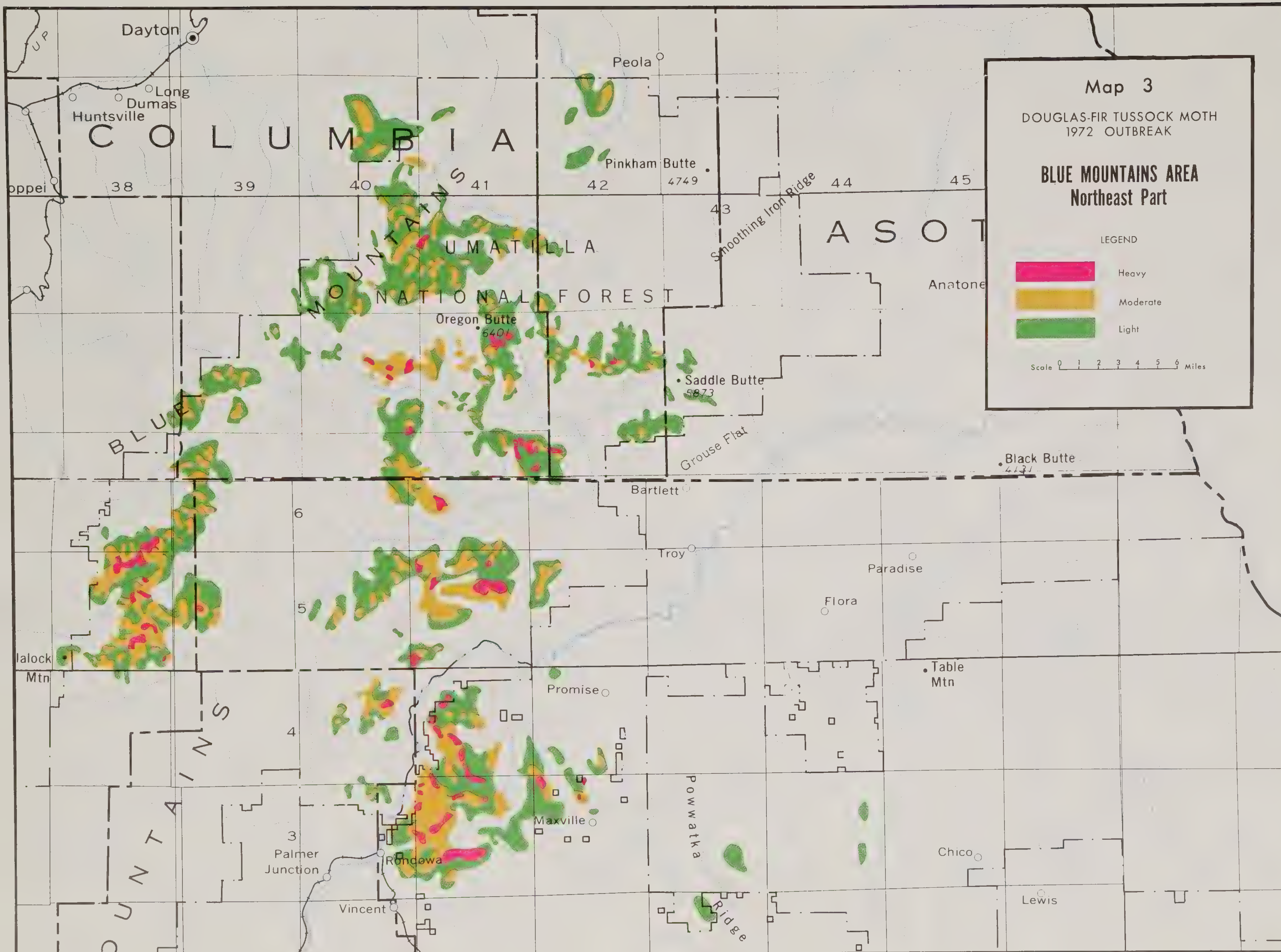
ACRES SPRAYED BY OWNERSHIP WITHIN STATES

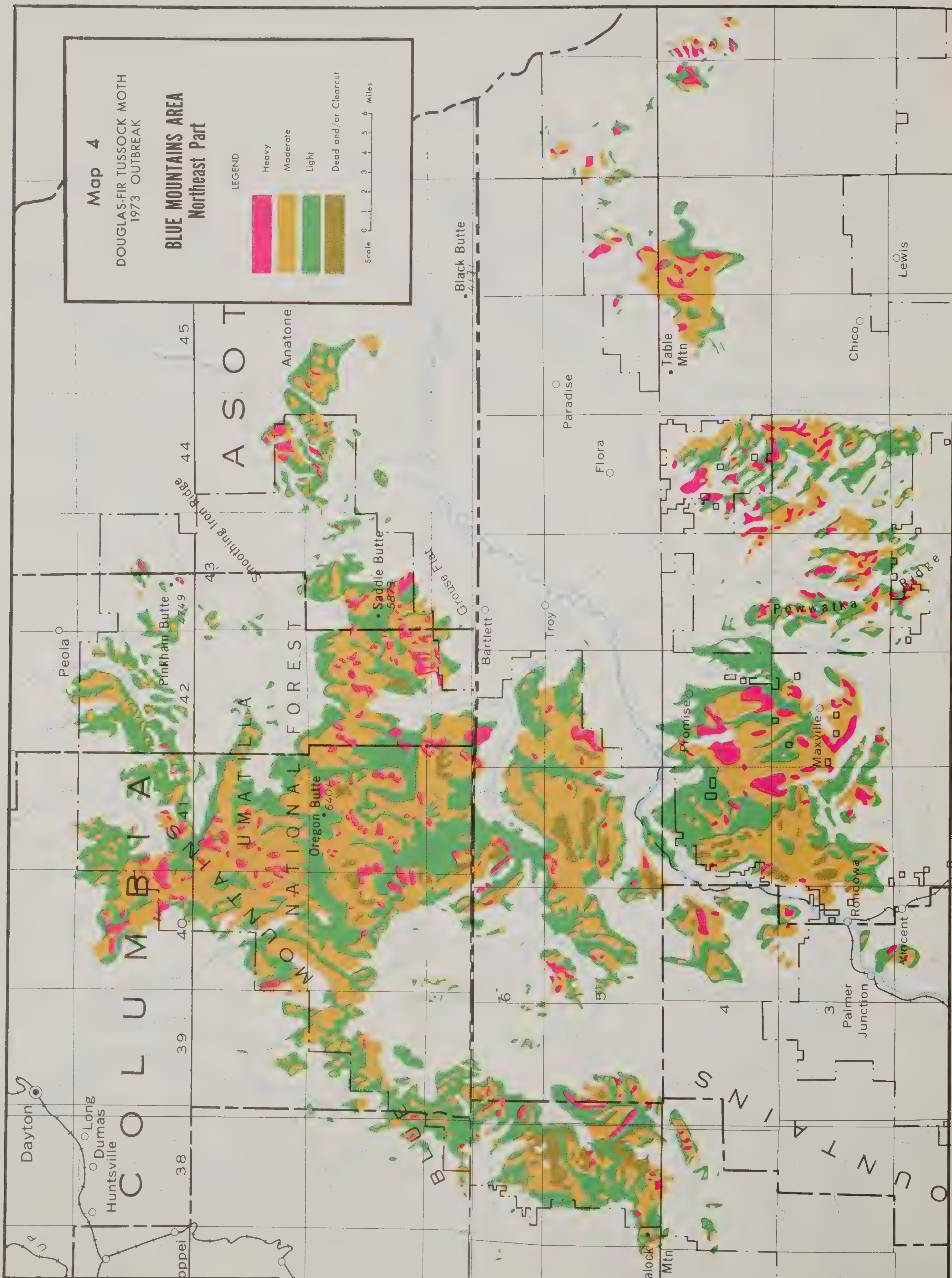
WASHINGTON IDAHO OREGON



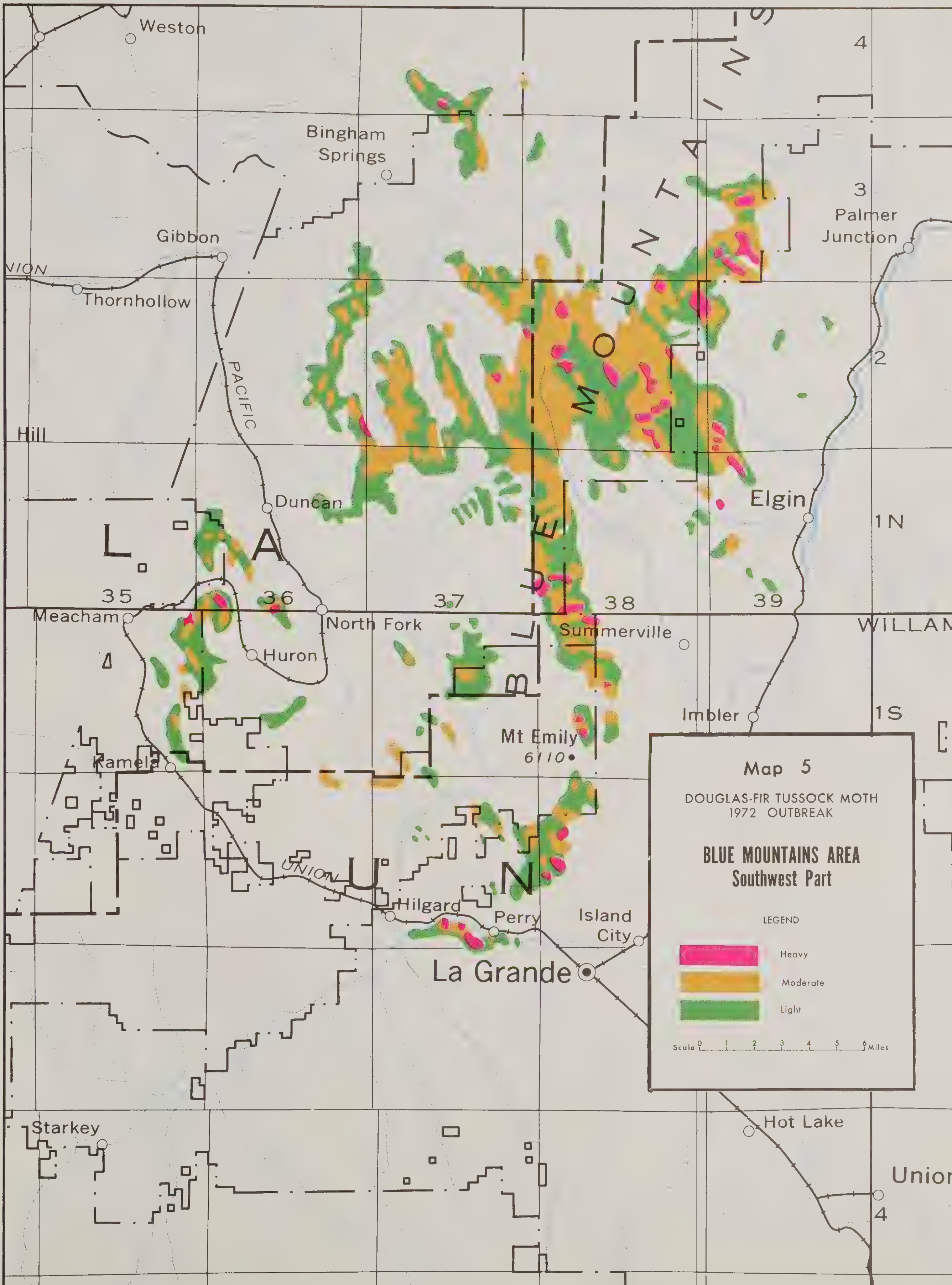
Map 1
1974
DOUGLAS-FIR TUSSOCK MOTH
CONTROL PROJECT
KEY MAP
OUTBREAK HISTORY MAPS
No. Area
2 Wallowa Area - 1973
3 NE Blue Mountains Area - 1972
4 NE Blue Mountains Area - 1973
5 SW Blue Mountains Area - 1972
6 SW Blue Mountains Area - 1973
7 Colville & NE Washington Areas - 1972
8 Colville & NE Washington Areas - 1973
9 Okanogan & Wenatchee Areas - 1972
10 Okanogan & Wenatchee Areas - 1973
MAPS 9 & 10
MAPS 7 & 8
MAPS 3 & 4
MAPS 5 & 6
MAP 2
BRITISH COLUMBIA
WASHINGTON
O
Vancouver
Victoria
Seattle
Tacoma
Olympia
Portland
Spokane
Yakima
Wenatchee
Walla Walla
Pendleton
La Grande
Baker
Burns
Boise

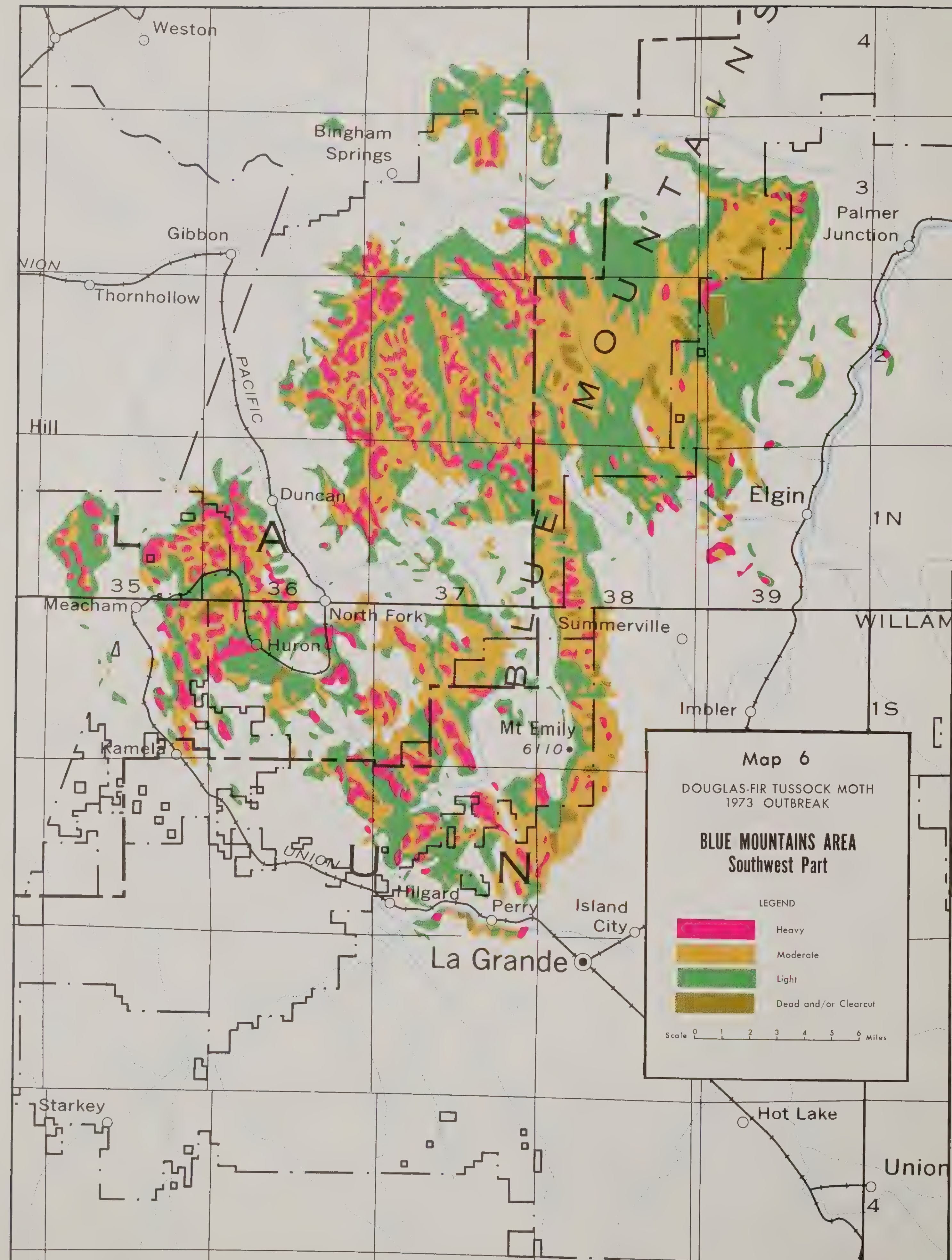

Map 2
DOUGLAS-FIR TUSSOCK MOTH
1973 OUTBREAK
WALLOWA AREA
LEGEND
Heavy
Moderate
Light
Scale 0 1 2 3 4 5 6 Miles
Minam
Wallowa
Elk Mtn
5122
Zumwalt
Imnaha
5485
Somers Pt
W A L L O W A
40 44 45 46 47 48 49 50
WILLAMET
1N
1S
2
3
4
5
6
7
Evans
Enterprise
(3756)
Joseph
(4190)
Dead Horse Ridge
Beeler Ridge
Harl Butte
6071
6895
6085
Hat Point
6982
S U M M I T R I D G E
HELLS CANYON
Cove
Union
Clark Mtn
Telocaset
North Powder
Pondosa
Medical Springs
Magpie Peak
Granite Butte
8679
Eagle Cap
9595
WALLOWA MTS
Red Mtn
9555
Sawtooth Mtn
7938
Cornucopia
Carson
Langrell
Homestead
Copperfield
OXBOW DAM

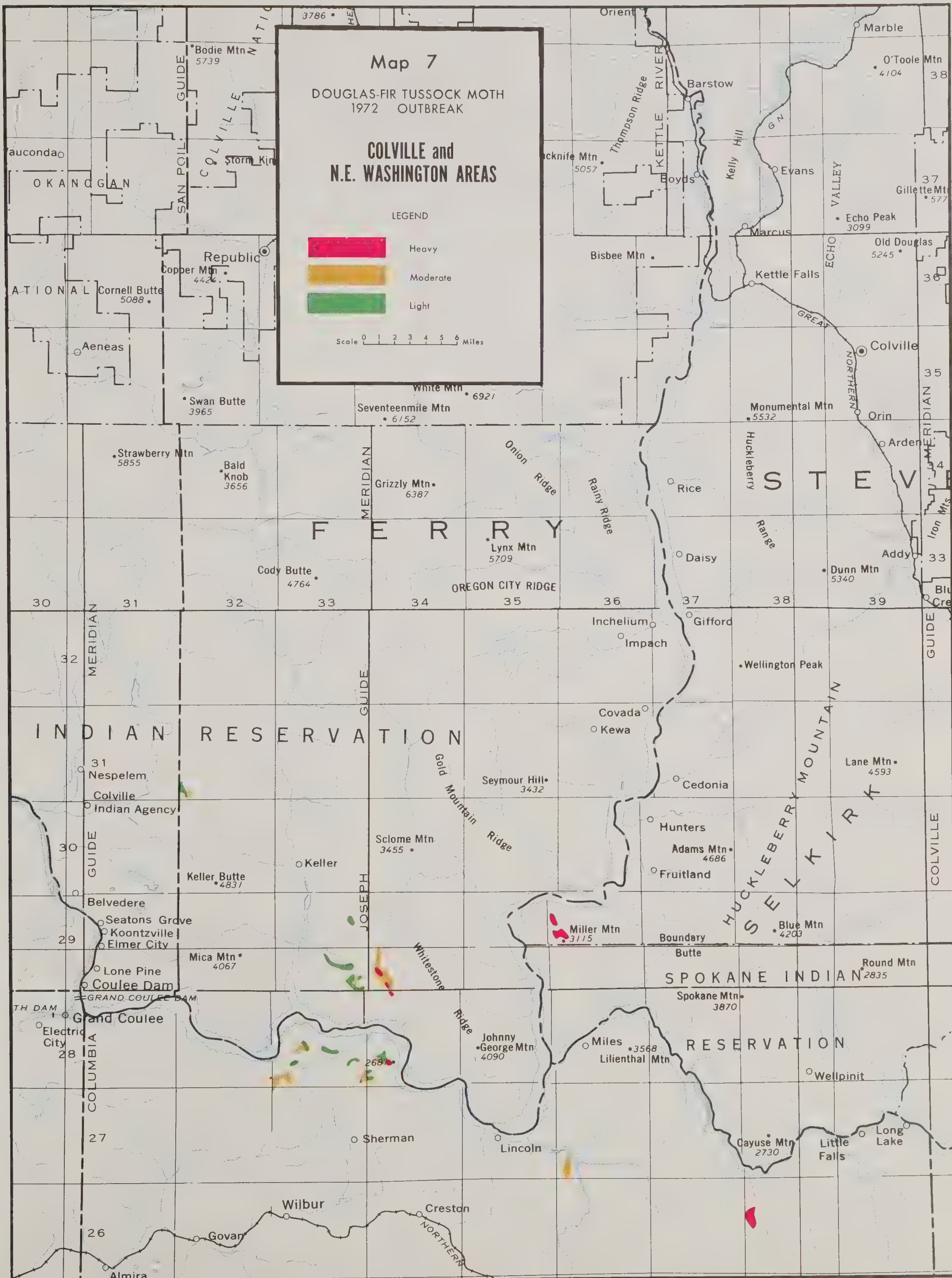

Map 3
DOUGLAS-FIR TUSSOCK MOTH
1972 OUTBREAK
BLUE MOUNTAINS AREA
Northeast Part
LEGEND
Heavy
Moderate
Light
Scale 0 1 2 3 4 5 6 Miles
COLUMBIA
ASOT
UMATILLA NATIONAL FOREST
BLUE MOUNTAINS
Dayton
Long
Dumas
Huntsville
Peola
Pinkham Butte
4749
Smoothing Iron Ridge
Anatone
Oregon Butte
6401
Saddle Butte
5873
Grouse Flat
Black Butte
Bartlett
Troy
Paradise
Flora
Table Mtn
Promise
Maxville
Powwatka
Ridge
Chico
Lewis
Rondowa
Palmer Junction
Vincent
38
39
40
41
42
43
44
45
6
5
4
3

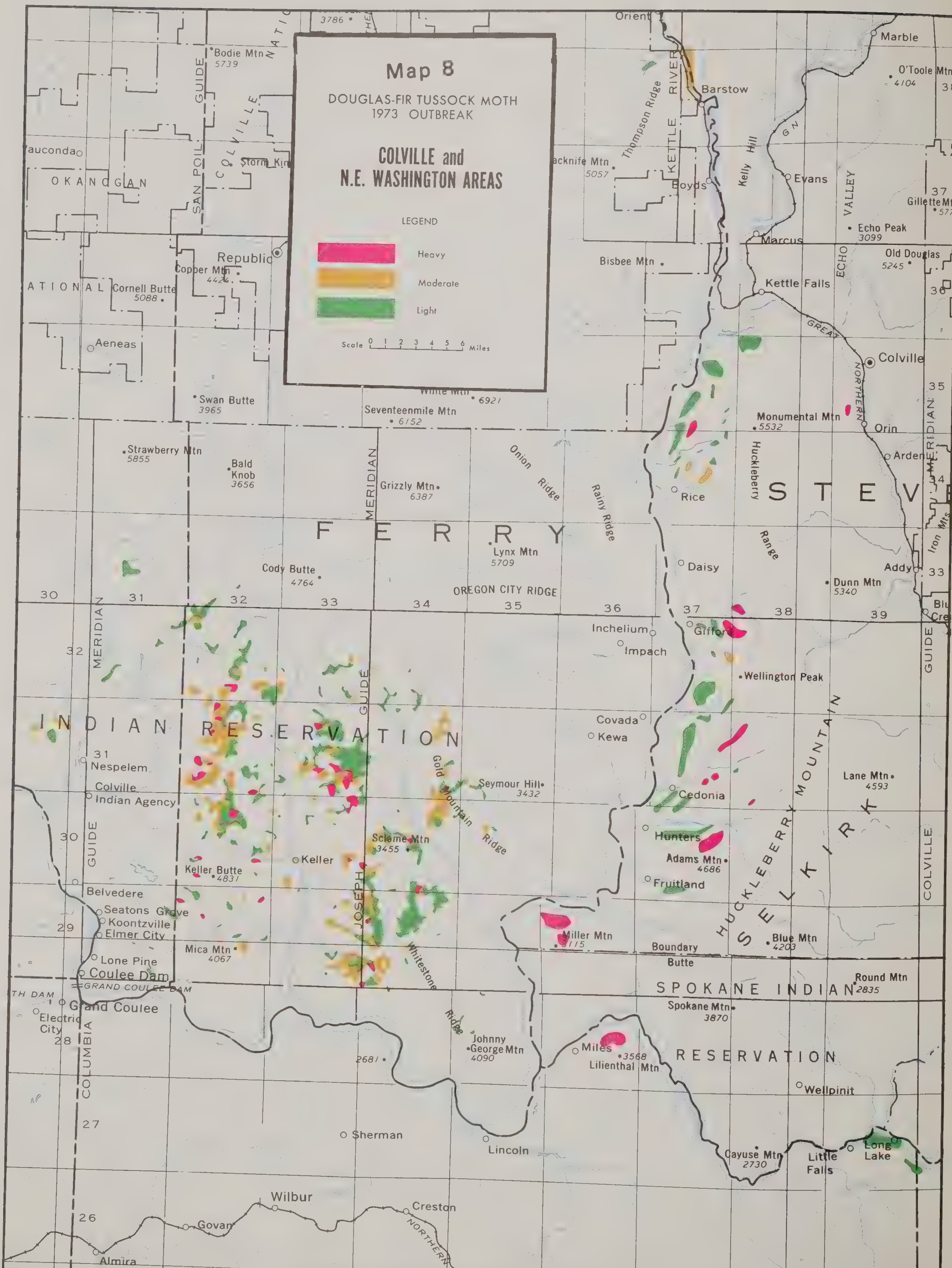


Map 4
DOUGLAS-FIR TUSSOCK MOTH
1973 OUTBREAK
BLUE MOUNTAINS AREA
Northeast Part
LEGEND
Heavy
Moderate
Light
Dead and/or Clearcut
Scale 0 1 2 3 4 5 6 Miles
COLUMBIA
ASOTIN
UMATILLA NATIONAL FOREST
BLUE
UNION
Dayton
Long
Dumas
Huntsville
Peola
Pinkham Butte
Smoothing Iron Ridge
Anatone
Black Butte
Saddle Butte
Grouse Flat
Oregon Butte
Bartlett
Troy
Paradise
Flora
Table Mtn
Chico
Lewis
Promise
Maxville
Powwatka Ridge
Rondowa
Vincent
Palmer Junction

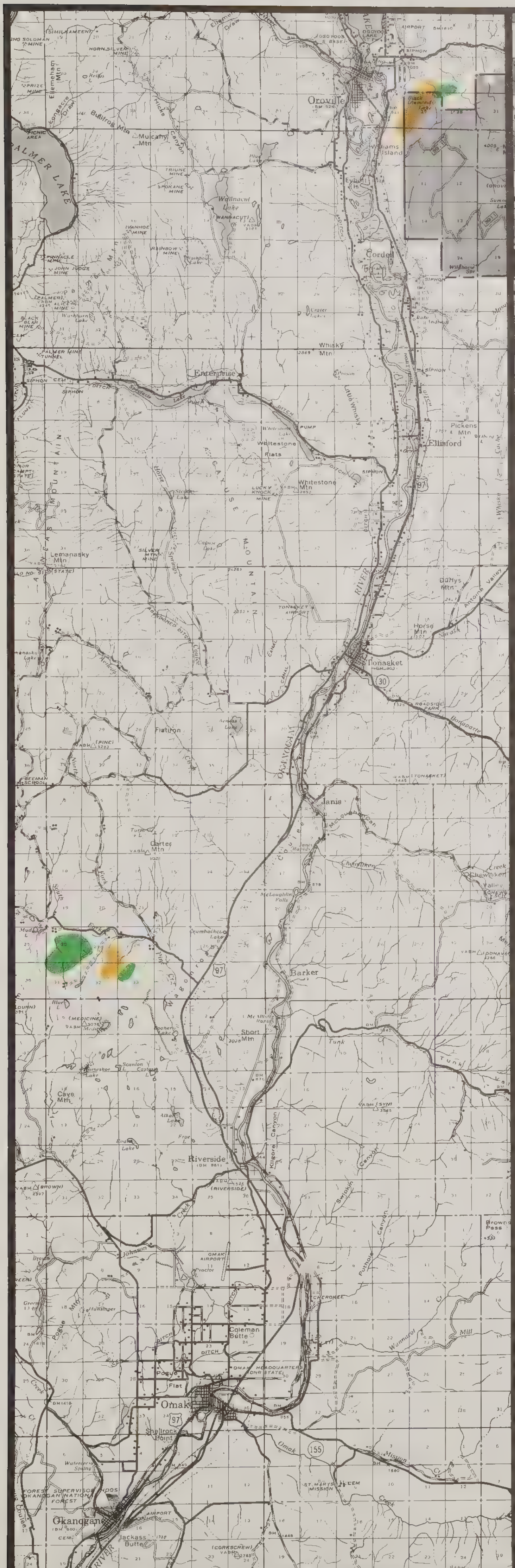

Map 5
DOUGLAS-FIR TUSSOCK MOTH
1972 OUTBREAK
BLUE MOUNTAINS AREA
Southwest Part
LEGEND
Heavy
Moderate
Light
Scale 0 1 2 3 4 5 6 Miles
Weston
Bingham Springs
Gibbon
Thornhollow
Hill
Duncan
Meacham
North Fork
Huron
Kamela
Hilgard
Perry
Island City
La Grande
Summerville
Imbler
Elgin
Palmer Junction
Mt Emily
6110
Starkey
Hot Lake
Union
BLUE MOUNTAINS
PACIFIC
UNION
WILLAM
35
36
37
38
39
4
3
2
1N
1S
4

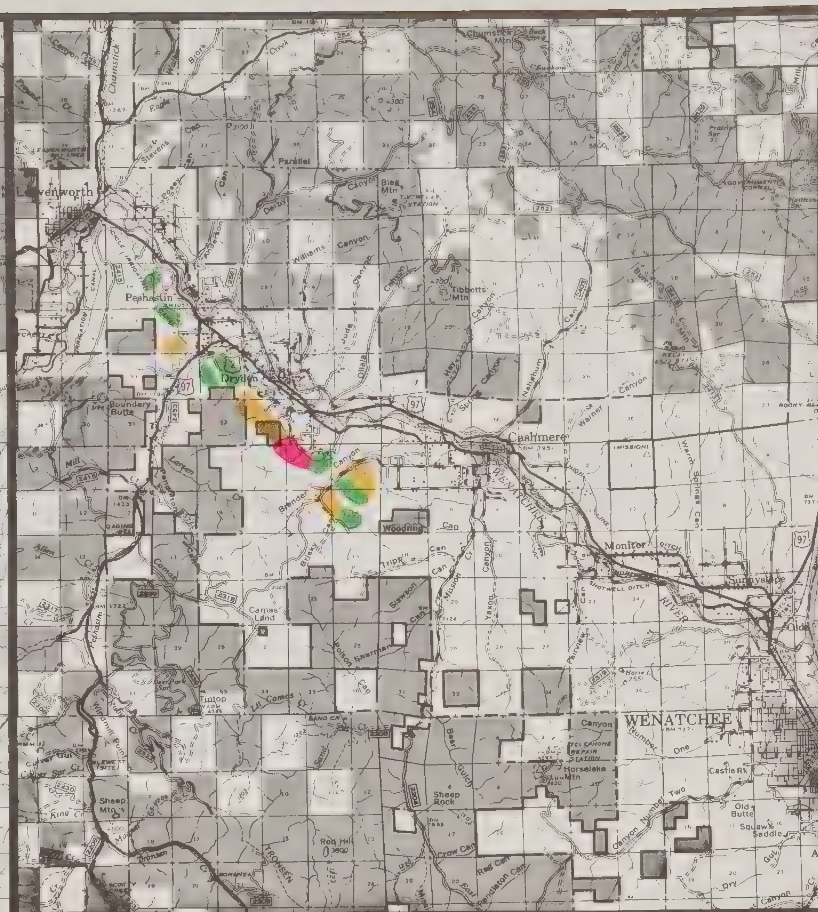

Map 6
DOUGLAS-FIR TUSSOCK MOTH
1973 OUTBREAK
BLUE MOUNTAINS AREA
Southwest Part
LEGEND
Heavy
Moderate
Light
Dead and/or Clearcut
Scale 0 1 2 3 4 5 6 Miles
Weston
Bingham Springs
Gibbon
Thornhollow
Hill
Duncan
Meacham
North Fork
Huron
Kamela
Summerville
Imbler
Elgin
Palmer Junction
Mt Emily
6110
Hilgard
Perry
Island City
La Grande
Starkey
Hot Lake
Union
UNION PACIFIC
BLUE MOUNTAINS
UMATILLA
UNION
WILLAM
35
36
37
38
39
4
3
2
1N
1S
4


Map 7
DOUGLAS-FIR TUSSOCK MOTH
1972 OUTBREAK
COLVILLE and
N.E. WASHINGTON AREAS
LEGEND
Heavy
Moderate
Light
Scale 0 1 2 3 4 5 6 Miles
FERRY
STEV
INDIAN RESERVATION
SPOKANE INDIAN RESERVATION
OKANOGAN
COLVILLE
SAN POIL
GUIDE
MERIDIAN
JOSEPH
COLUMBIA
KETTLE RIVER
ECHO VALLEY
SELKIRK
HUCKLEBERRY MOUNTAIN
Huckleberry Range
Kelly Hill
Thompson Ridge
Onion Ridge
Rainy Ridge
Gold Mountain Ridge
Whitestone Ridge
OREGON CITY RIDGE
Iron Mts
GREAT NORTHERN
Bodie Mtn 5739
Storm King
Republic
Copper Mtn 4424
Cornell Butte 5088
Aeneas
Swan Butte 3965
White Mtn 6921
Seventeenmile Mtn 6152
Strawberry Mtn 5855
Bald Knob 3656
Grizzly Mtn 6387
Lynx Mtn 5709
Cody Butte 4764
Jackknife Mtn 5057
Bisbee Mtn
Orient
Barstow
Boyds
Evans
Marcus
Marble
O'Toole Mtn 4104
Gillette Mtn 577
Echo Peak 3099
Old Douglas 5245
Kettle Falls
Colville
Monumental Mtn 5532
Orin
Arden
Rice
Daisy
Addy
Dunn Mtn 5340
Inchelium
Impach
Gifford
Wellington Peak
Covada
Kewa
Seymour Hill 3432
Cedonia
Lane Mtn 4593
Hunters
Adams Mtn 4686
Fruitland
Sclome Mtn 3455
Keller
Keller Butte 4831
Nespelem
Colville Indian Agency
Belvedere
Seatons Grove
Koontzville
Elmer City
Lone Pine
Coulee Dam
GRAND COULEE DAM
Grand Coulee
Electric City
Mica Mtn 4067
Miller Mtn 3115
Boundary Butte
Blue Mtn 4203
Round Mtn 2835
Spokane Mtn 3870
Johnny George Mtn 4090
Miles
Lilienthal Mtn 3568
Wellpinit
Cayuse Mtn 2730
Little Falls
Long Lake
Sherman
Lincoln
Wilbur
Creston
Govan
Almira
NORTHERN
Vaconda
30
31
32
33
34
35
36
37
38
39
26
27
28
29



Map 8
DOUGLAS-FIR TUSSOCK MOTH
1973 OUTBREAK
COLVILLE and
N.E. WASHINGTON AREAS
LEGEND
Heavy
Moderate
Light
Scale 0 1 2 3 4 5 6 Miles
Orient
Marble
O'Toole Mtn
4104
Barstow
Thompson Ridge
KETTLE RIVER
Kelly Hill
Evans
VALLEY
Gillette Mtn
Echo Peak
3099
Boyds
Marcus
Old Douglas
5245
Bisbee Mtn
Kettle Falls
ECHO
GREAT NORTHERN
Colville
Bodie Mtn
5739
GUIDE
COLVILLE
SAN POIL
Storm King
OKANOGAN
Republic
Copper Mtn
4424
Cornell Butte
5088
Aeneas
Swan Butte
3965
Seventeenmile Mtn
6152
6921
Monumental Mtn
5532
Orin
Arden
Strawberry Mtn
5855
Bald Knob
3656
Grizzly Mtn
6387
MERIDIAN
Onion Ridge
Rainy Ridge
Huckleberry Range
Rice
STEV
FERRY
Lynx Mtn
5709
Cody Butte
4764
OREGON CITY RIDGE
Daisy
Addy
Dunn Mtn
5340
30
31
32
33
34
35
36
37
38
39
Inchelium
Impach
Gifford
Wellington Peak
INDIAN RESERVATION
Covada
Kewa
Nespelem
Colville Indian Agency
Gold Mountain Ridge
Seymour Hill
3432
Cedonia
Lane Mtn
4593
HUCKLEBERRY MOUNTAIN
SELKIRK
Hunters
Adams Mtn
4686
Fruitland
Sclome Mtn
3455
Keller
Keller Butte
4831
Belvedere
Seatons Grove
Koontzville
Elmer City
JOSEPH
Whitestone Ridge
Miller Mtn
5115
Boundary Butte
Blue Mtn
4203
Mica Mtn
4067
Lone Pine
Coulee Dam
GRAND COULEE DAM
Grand Coulee
Electric City
COLUMBIA
SPOKANE INDIAN RESERVATION
Round Mtn
2835
Spokane Mtn
3870
Johnny George Mtn
4090
Miles
3568
Lilienthal Mtn
2681
Wellpinit
Sherman
Lincoln
Cayuse Mtn
2730
Little Falls
Long Lake
Wilbur
Creston
Govan
NORTHERN
Almira





Map 8A

DOUGLAS-FIR TUSSOCK MOTH
1971 OUTBREAK

WENATCHEE and OKANOGAN AREAS

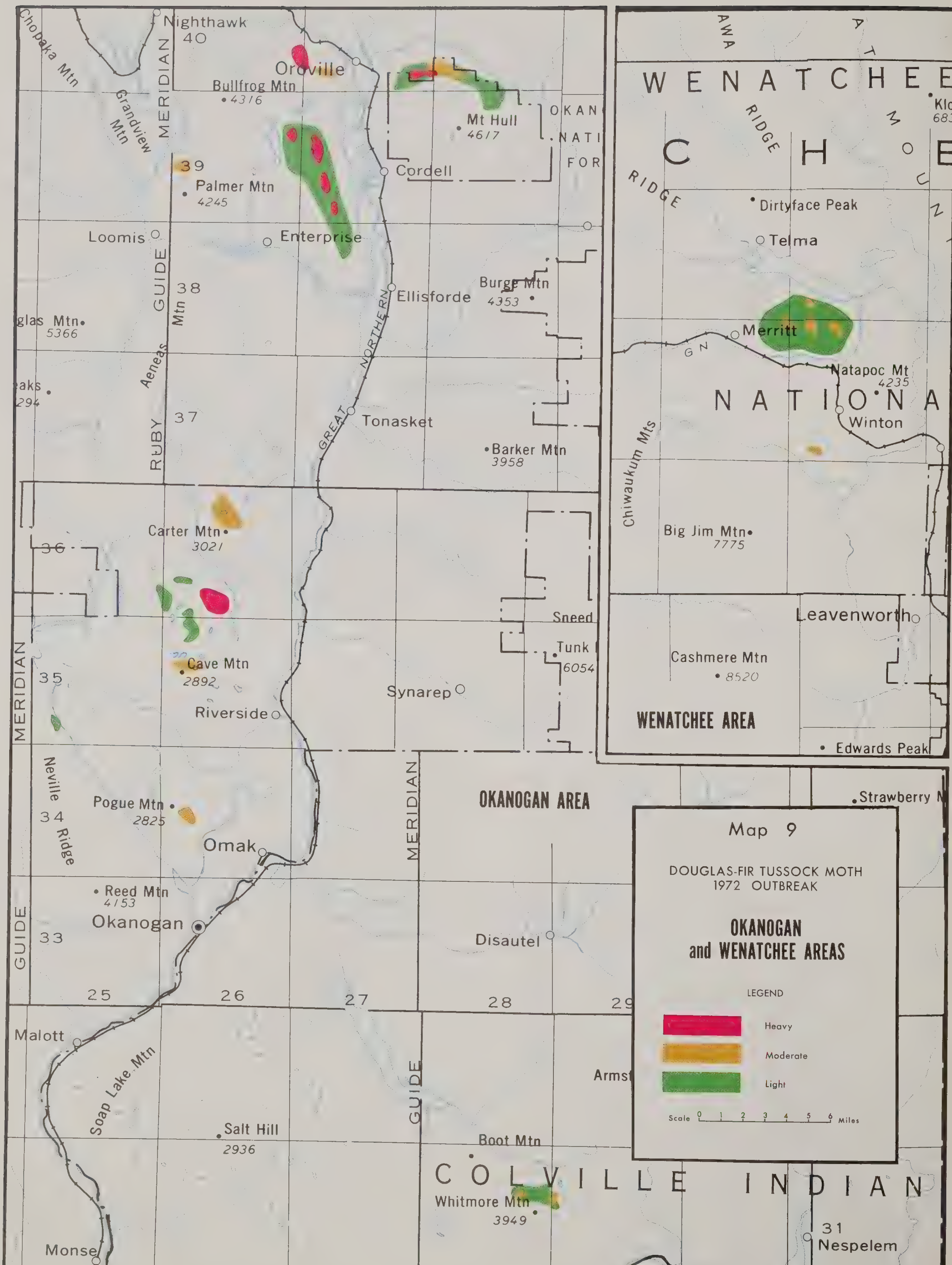
LEGEND

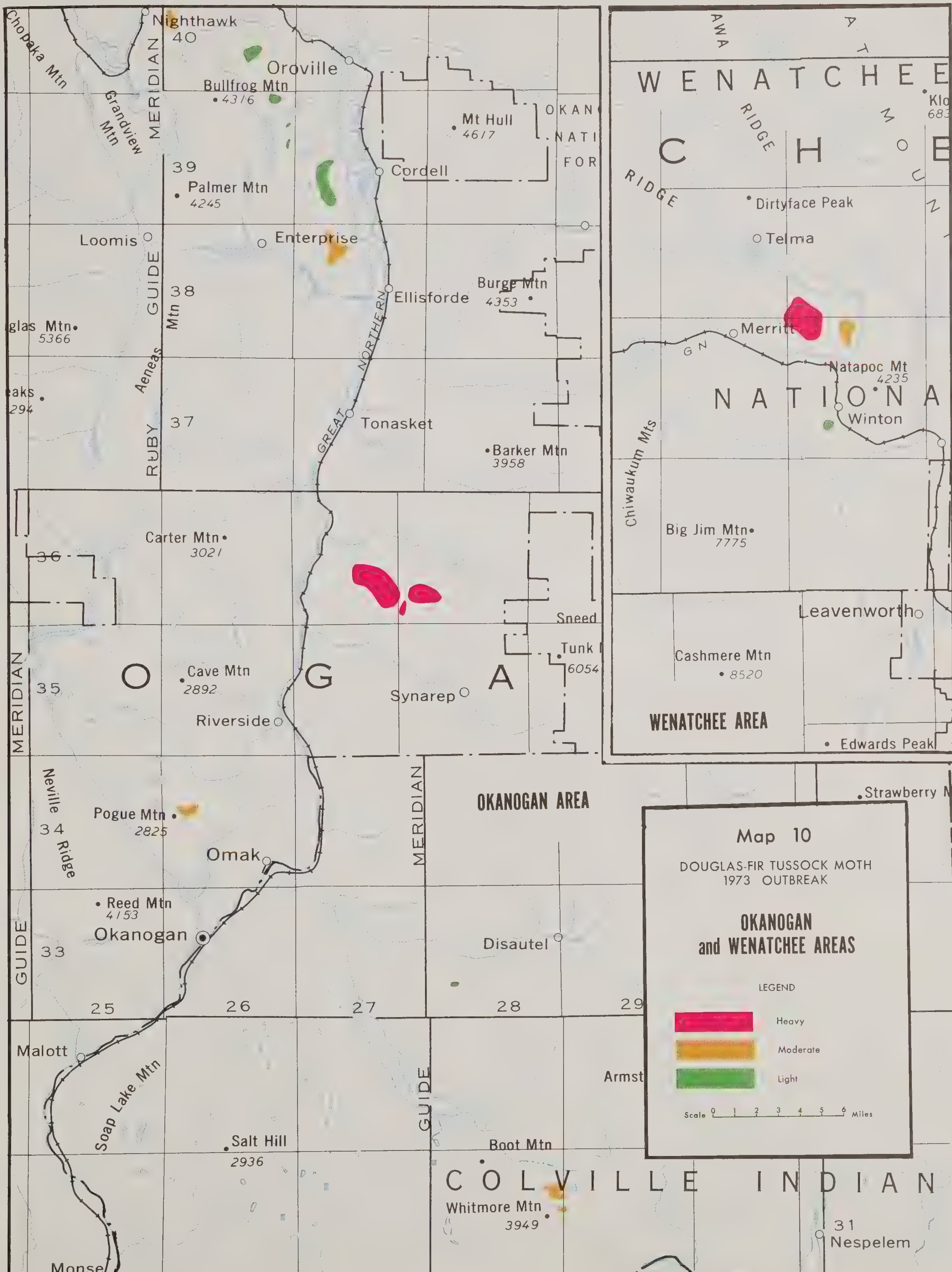
HEAVY

MODERATE

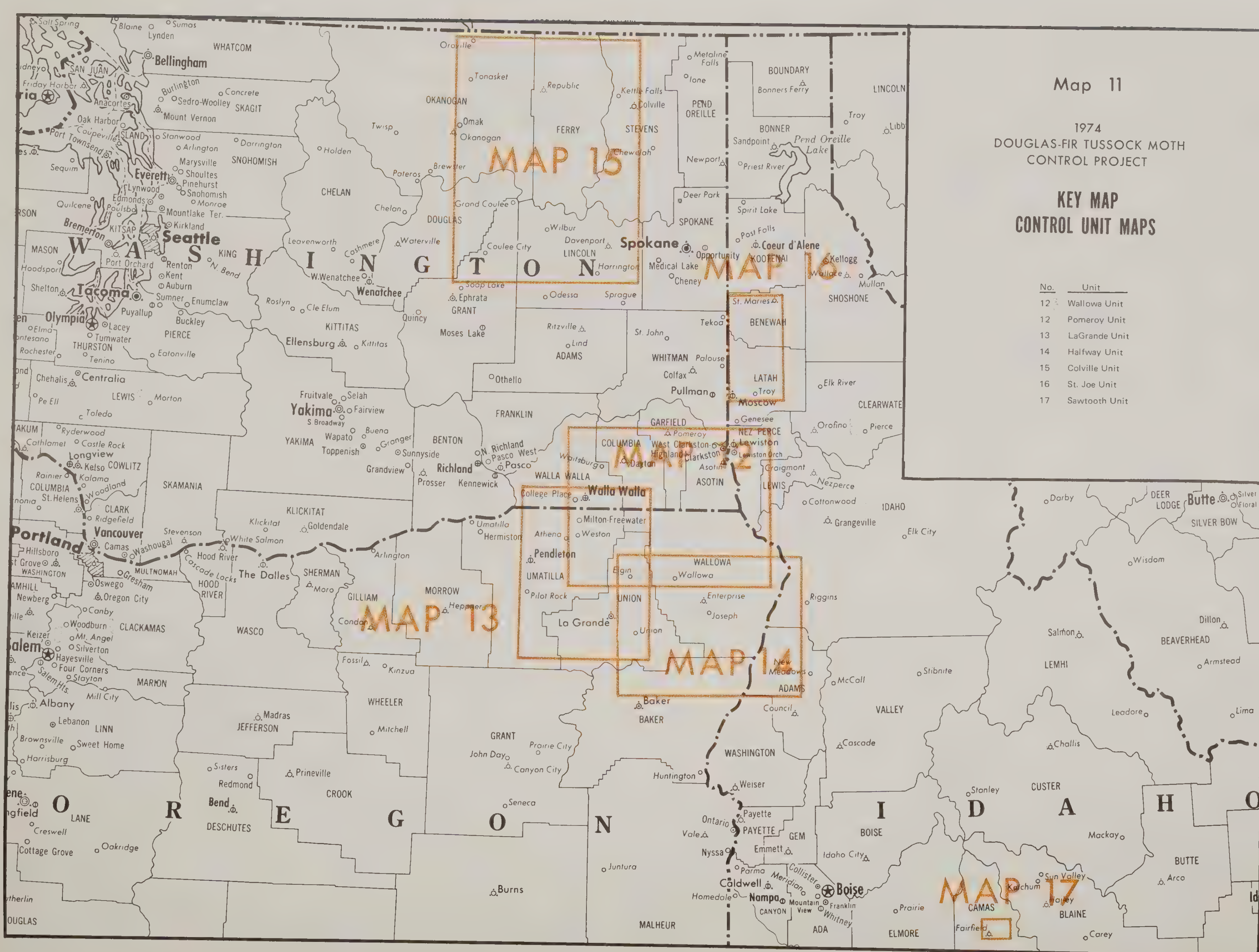
LIGHT

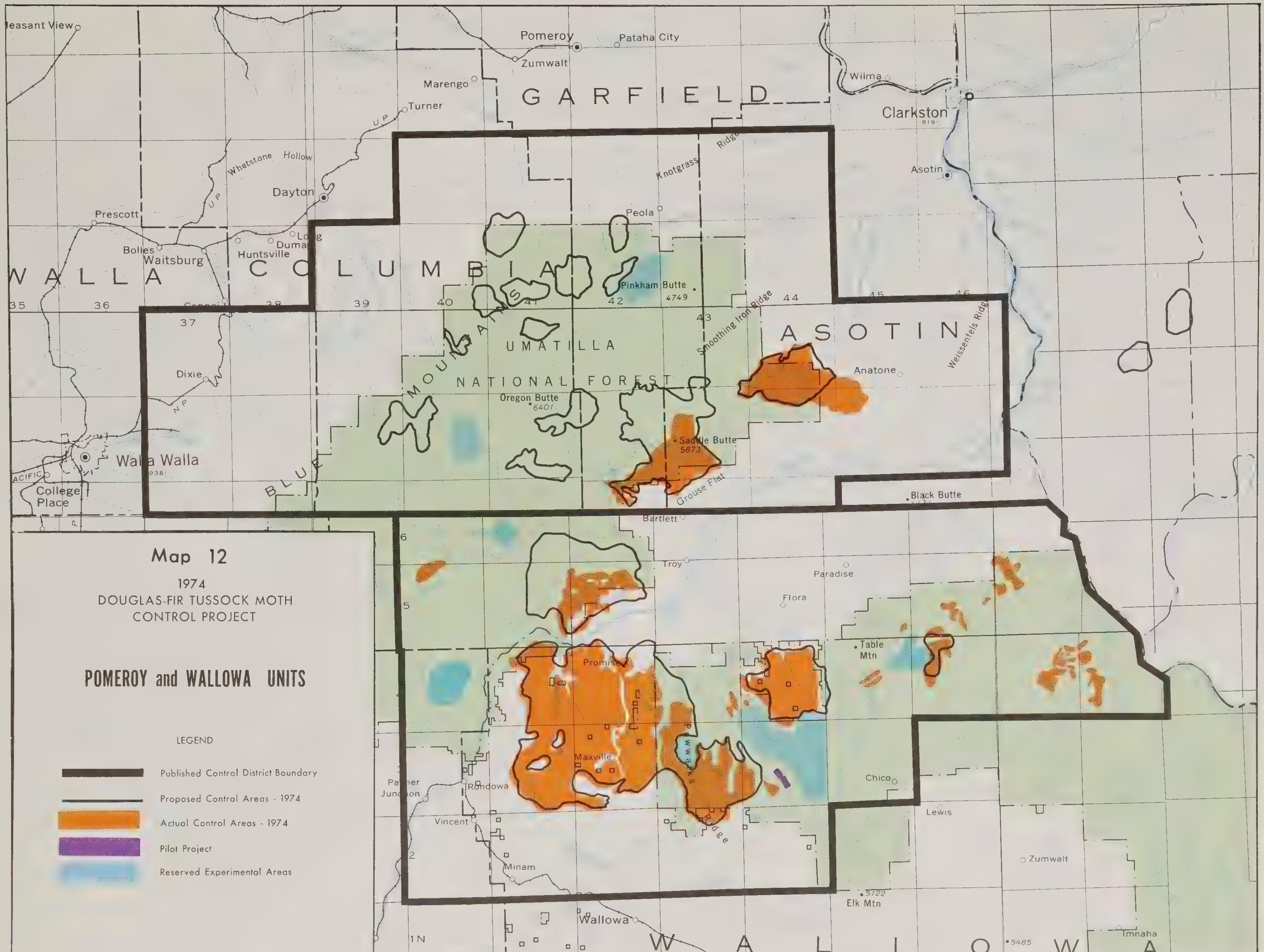
Scale 0 1 2 3 4 5 6 Miles


Map 9
DOUGLAS-FIR TUSSOCK MOTH
1972 OUTBREAK
OKANOGAN
and WENATCHEE AREAS
LEGEND
Heavy
Moderate
Light
Scale 0 1 2 3 4 5 6 Miles
OKANOGAN AREA
WENATCHEE AREA
Nighthawk
Oroville
Bullfrog Mtn
4316
Chopaka Mtn
Grandview Mtn
Mt Hull
4617
Cordell
Palmer Mtn
4245
Loomis
Enterprise
Ellisforde
Burge Mtn
4353
Tonasket
Barker Mtn
3958
Carter Mtn
3021
Cave Mtn
2892
Riverside
Synarep
Sneed
Tunk
6054
Pogue Mtn
2825
Omak
Reed Mtn
4153
Okanogan
Disautel
Malott
Soap Lake Mtn
Salt Hill
2936
Boot Mtn
Whitmore Mtn
3949
Monse
Nespelem
Neville Ridge
Aeneas Mtn
RUBY GUIDE MERIDIAN
GREAT NORTHERN
COLVILLE INDIAN
WENATCHEE
Dirtyface Peak
Telma
Merritt
Natapoc Mt
4235
Winton
Chiwaukum Mts
Big Jim Mtn
7775
Leavenworth
Cashmere Mtn
8520
Edwards Peak
Strawberry



Map 10
DOUGLAS-FIR TUSSOCK MOTH
1973 OUTBREAK
OKANOGAN
and WENATCHEE AREAS
LEGEND
Heavy
Moderate
Light
Scale 0 1 2 3 4 5 6 Miles
OKANOGAN AREA
WENATCHEE AREA
Nighthawk
Oroville
Bullfrog Mtn 4316
Mt Hull 4617
Cordell
Palmer Mtn 4245
Loomis
Enterprise
Ellisforde
Burge Mtn 4353
Tonasket
Barker Mtn 3958
Carter Mtn 3021
Cave Mtn 2892
Riverside
Synarep
Sneed
Pogue Mtn 2825
Omak
Reed Mtn 4153
Okanogan
Disautel
Malott
Soap Lake Mtn
Salt Hill 2936
Boot Mtn
Whitmore Mtn 3949
Monse
Nespelem
COLVILLE INDIAN
GREAT NORTHERN
RUBY
GUIDE
MERIDIAN
Chopaka Mtn
Grandview Mtn
Aeneas Mtn
Neville Ridge
WENATCHEE
Dirtyface Peak
Telma
Merritt
Natapoc Mt 4235
NATIONA
Winton
Chiwaukum Mts
Big Jim Mtn 7775
Leavenworth
Cashmere Mtn 8520
Edwards Peak
Strawberry


Map 11
1974
DOUGLAS-FIR TUSSOCK MOTH
CONTROL PROJECT
KEY MAP
CONTROL UNIT MAPS
No. Unit
12 Wallowa Unit
12 Pomeroy Unit
13 LaGrande Unit
14 Halfway Unit
15 Colville Unit
16 St. Joe Unit
17 Sawtooth Unit
MAP 12
MAP 13
MAP 14
MAP 15
MAP 16
MAP 17
WASHINGTON
OREGON
IDAHO
Seattle
Spokane
Portland
Yakima
Walla Walla
Pendleton
La Grande
Baker
Lewiston
Boise
Coeur d'Alene



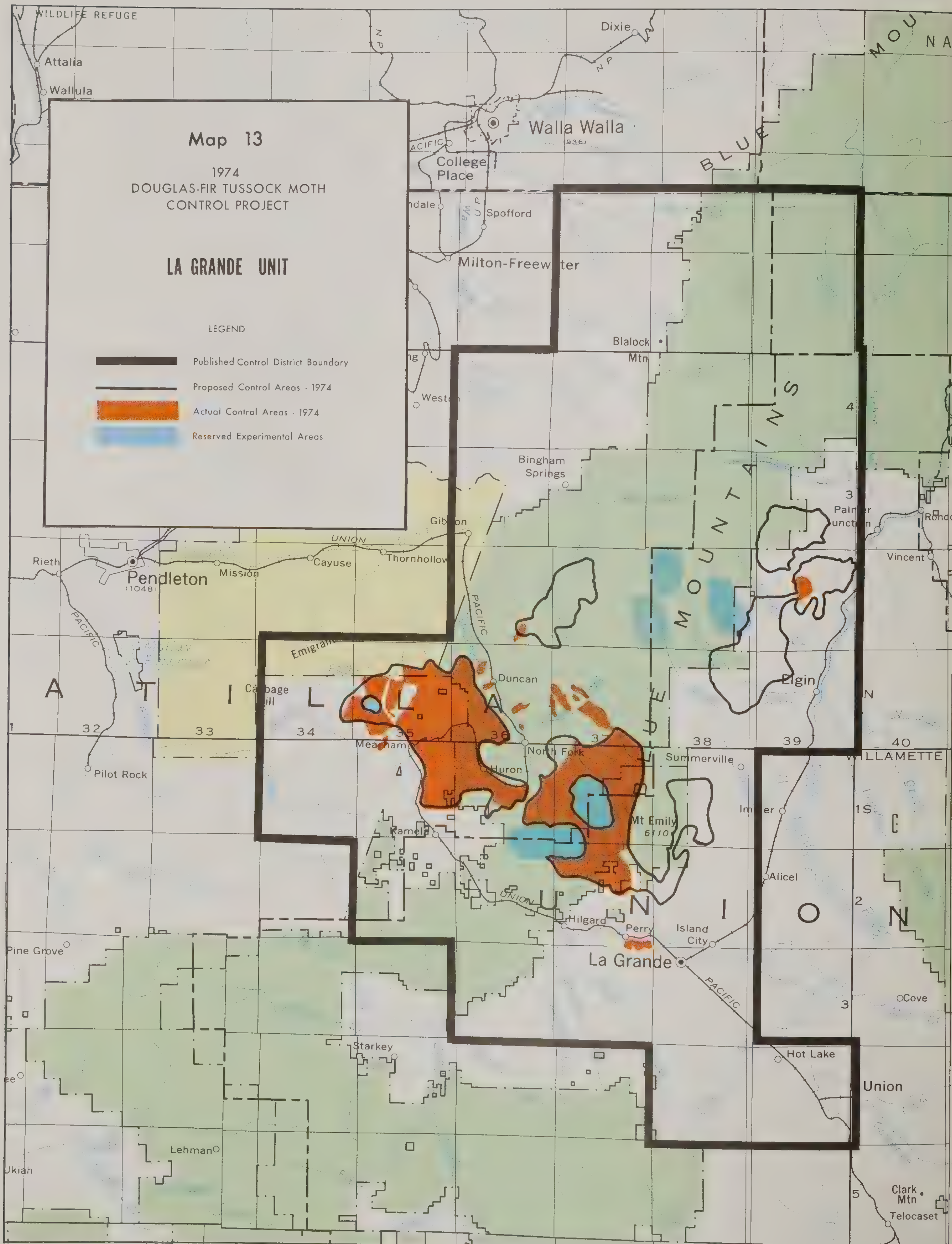
Map 12

1974
DOUGLAS-FIR TUSSOCK MOTH
CONTROL PROJECT

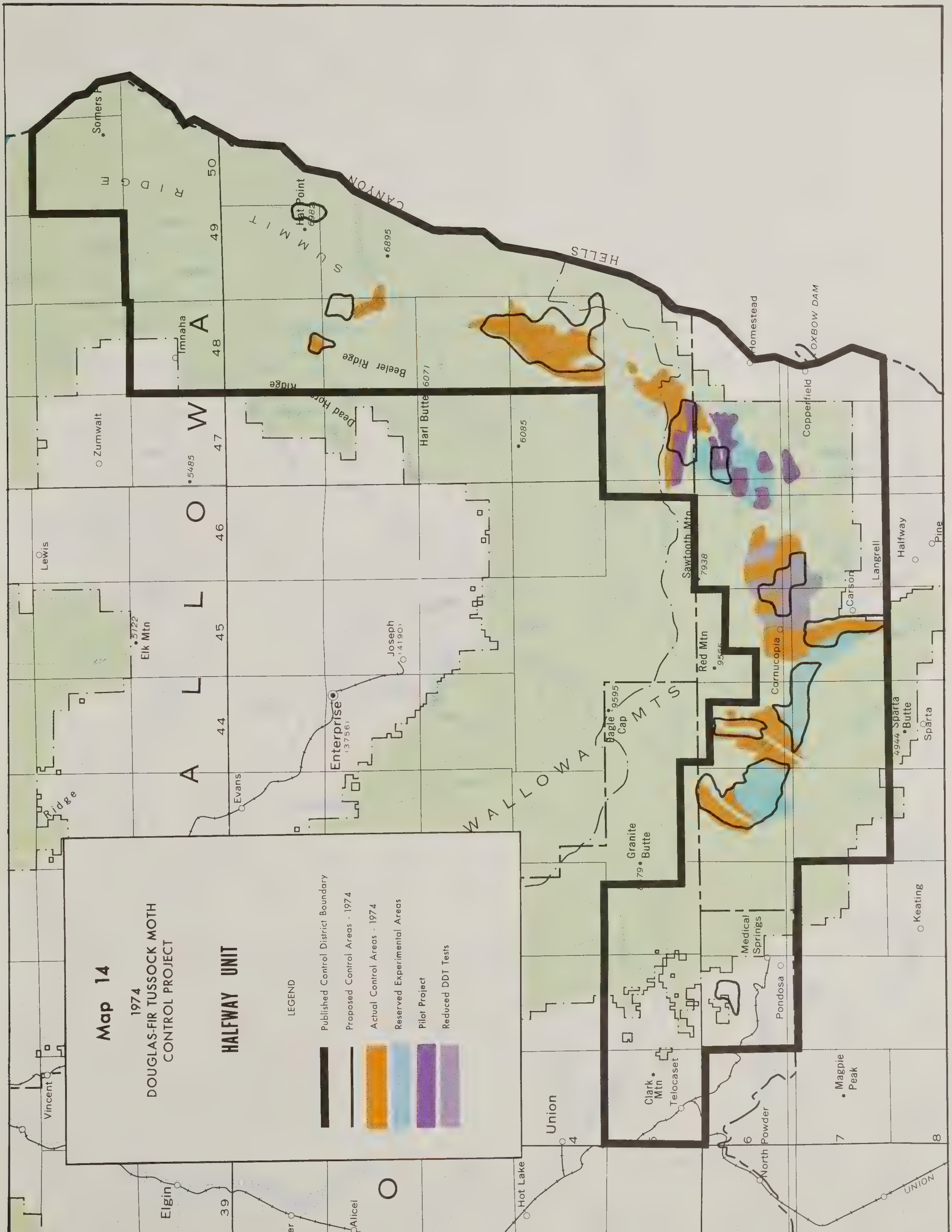
POMEROY and WALLOWA UNITS

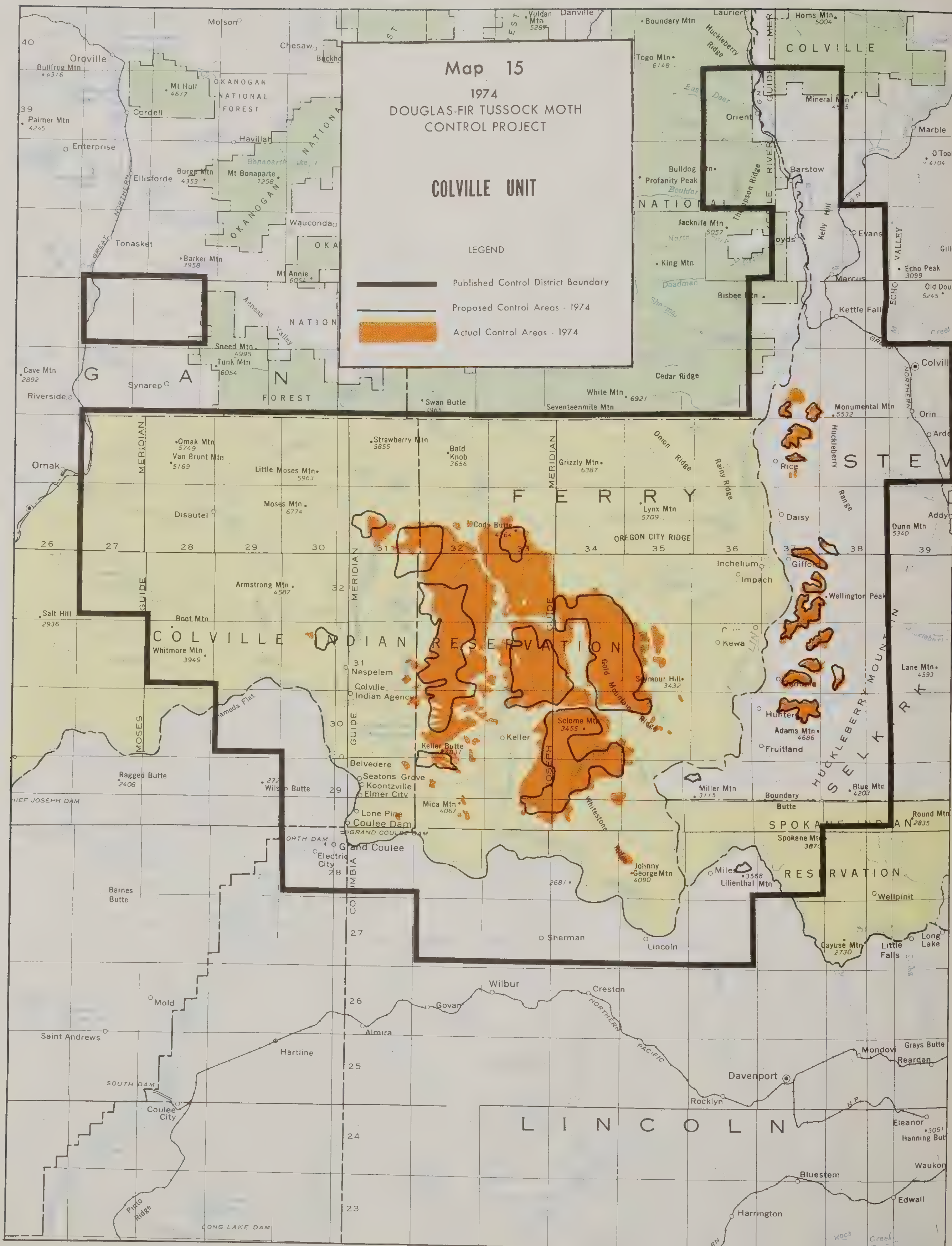
LEGEND

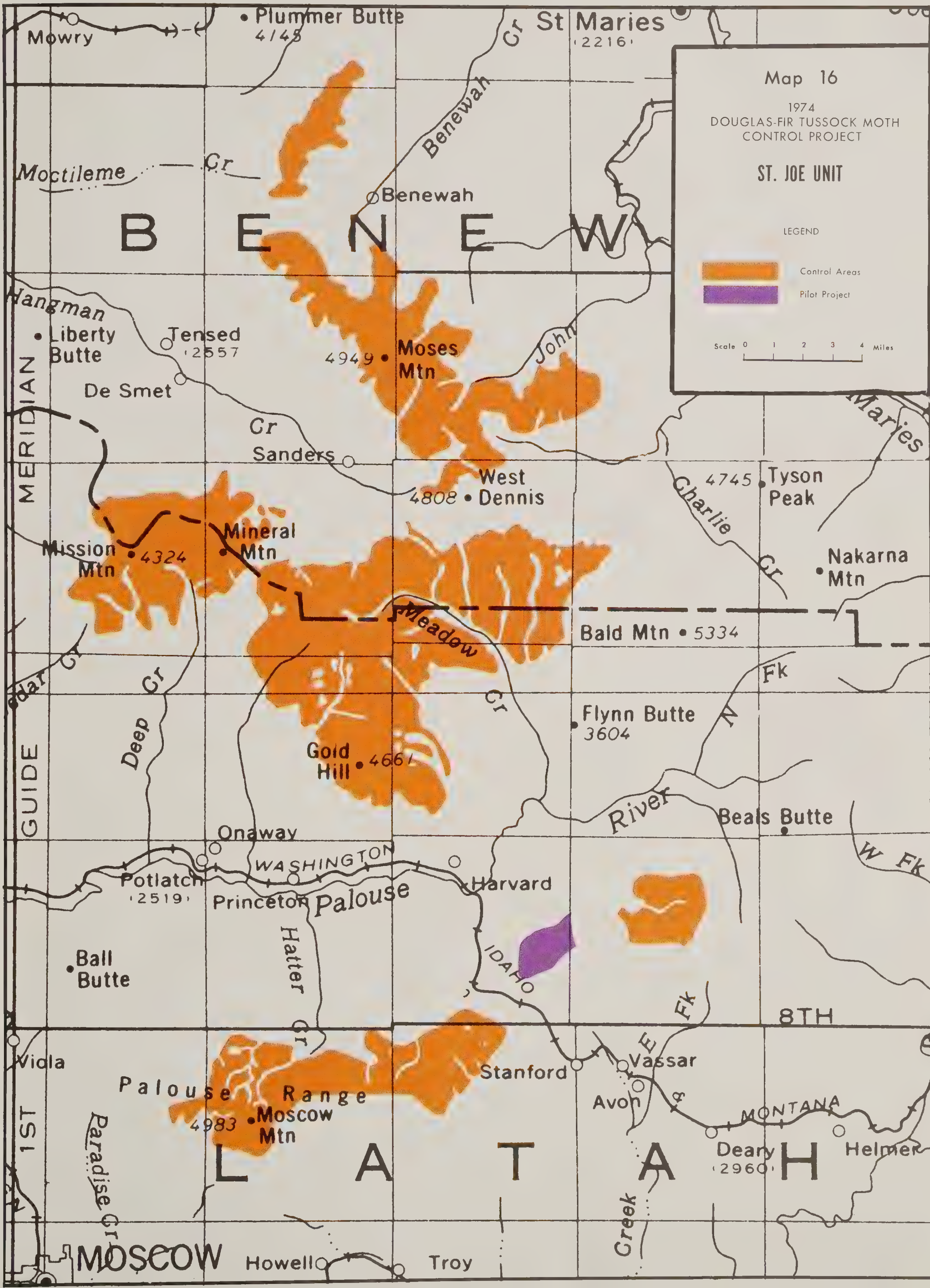
- Published Control District Boundary
- Proposed Control Areas - 1974
- Actual Control Areas - 1974
- Pilot Project
- Reserved Experimental Areas

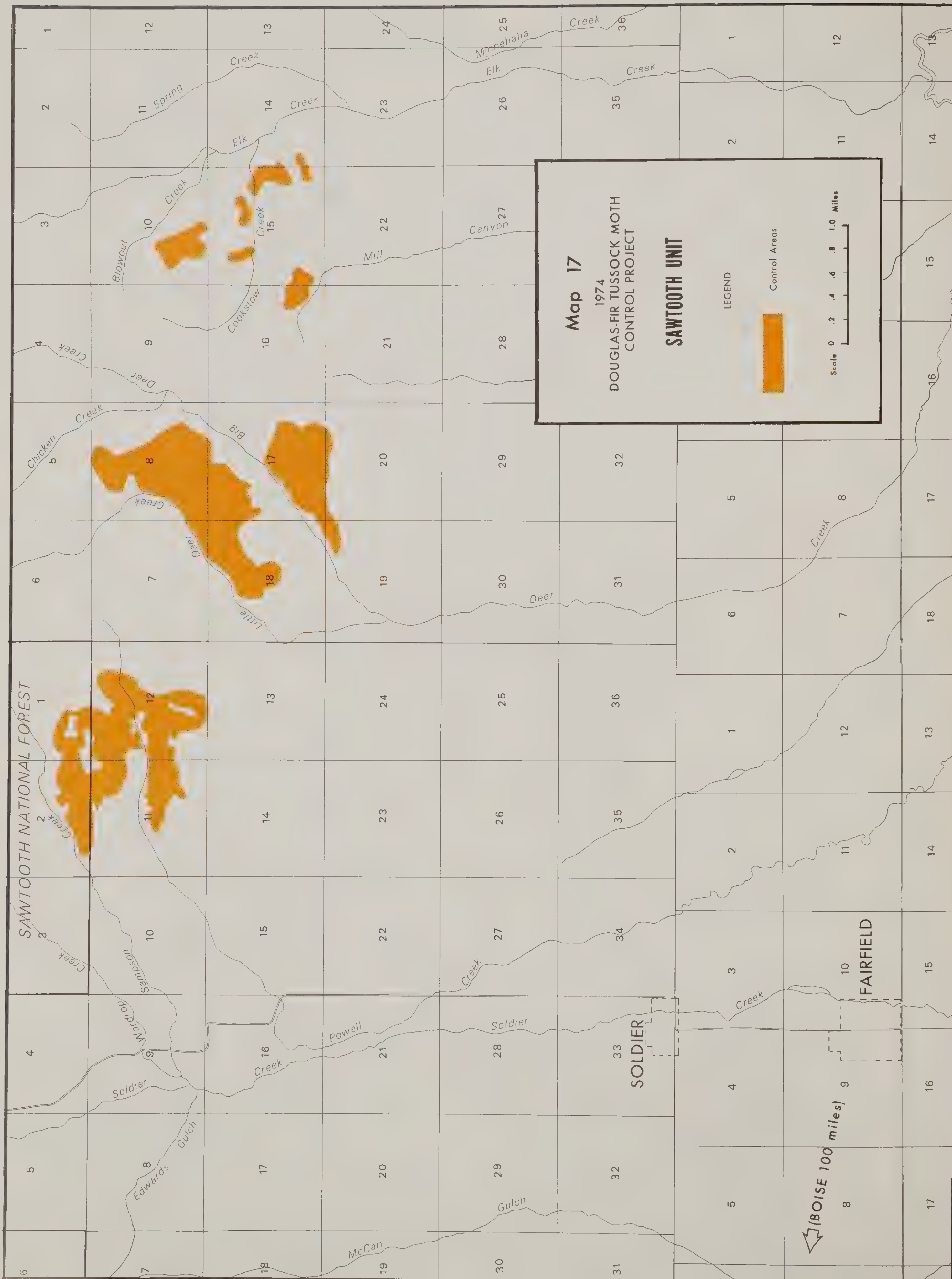


Map 13
1974
DOUGLAS-FIR TUSSOCK MOTH
CONTROL PROJECT
LA GRANDE UNIT
LEGEND
Published Control District Boundary
Proposed Control Areas - 1974
Actual Control Areas - 1974
Reserved Experimental Areas
WILDLIFE REFUGE
Attalia
Wallula
Dixie
Walla Walla
College Place
Spofford
Milton-Freewater
Blalock Mtn
Weston
Bingham Springs
Gibbon
Thornhollow
Cayuse
Mission
Pendleton
Rieth
Pilot Rock
Cabbage Hill
Emigrant
Duncan
Meacham
North Fork
Huron
Kamela
Summerville
Imbler
Mt Emily 6110
Elgin
Palmer Junction
Rondo
Vincent
Alicel
Hilgard
Perry
Island City
La Grande
Cove
Hot Lake
Union
Starkey
Pine Grove
Lehman
Ukiah
Clark Mtn
Telocaset
BLUE MOUNTAINS
UMATILLA
UNION
WILLAMETTE
PACIFIC
UNION


Map 14
1974
DOUGLAS-FIR TUSSOCK MOTH
CONTROL PROJECT
HALFWAY UNIT
LEGEND
Published Control District Boundary
Proposed Control Areas - 1974
Actual Control Areas - 1974
Reserved Experimental Areas
Pilot Project
Reduced DDT Tests
WALLOWA
WALLOWA MTS
SUMMIT RIDGE
HELLS CANYON
OXBOW DAM
Somers Pt
Hat Point
Imnaha
Beeler Ridge
Dead Horse Ridge
Harl Butte
Zumwalt
Lewis
Elk Mtn
Joseph
Enterprise
Evans
Eagle Cap
Granite Butte
Sawtooth Mtn
Red Mtn
Cornucopia
Homestead
Copperfield
Carson
Langrell
Halfway
Pine
Sparta Butte
Sparta
Keating
Medical Springs
Pondosa
Clark Mtn
Telocaset
Magpie Peak
North Powder
Union
Hot Lake
Elgin
Alicel
Vincent
UNION


Map 15
1974
DOUGLAS-FIR TUSSOCK MOTH
CONTROL PROJECT
COLVILLE UNIT
LEGEND
Published Control District Boundary
Proposed Control Areas - 1974
Actual Control Areas - 1974
OKANOGAN NATIONAL FOREST
COLVILLE NATIONAL FOREST
COLVILLE INDIAN RESERVATION
SPOKANE INDIAN RESERVATION
FERRY
STEV
LINCOLN
Oroville
Molson
Chesaw
Tonasket
Ellisforde
Enterprise
Havillah
Wauconda
Omak
Disautel
Nespelem
Colville Indian Agency
Keller
Belvedere
Seatons Grove
Koontzville
Elmer City
Lone Pine
Coulee Dam
Grand Coulee
Electric City
Inchelium
Impach
Kewa
Rice
Daisy
Gifford
Hunters
Fruitland
Orient
Barstow
Kettle Falls
Colville
Evans
Marble
Danville
Laurier
Sherman
Lincoln
Wilbur
Creston
Govan
Almira
Hartline
Davenport
Rocklyn
Mondovi
Reardan
Eleanor
Harrington
Edwall
Bluestem
Wellpinit
Miles
Long Lake
Little Falls
Coulee City
Saint Andrews
Mold
Barnes Butte
Sclome Mtn 3455
Keller Butte
Mica Mtn 4067
Cody Butte
Seymour Hill 3432
Wellington Peak
Adams Mtn 4686
Lane Mtn 4593
Dunn Mtn 5340
Monumental Mtn 5532
Grizzly Mtn 6387
Lynx Mtn 5709
Moses Mtn 6774
Little Moses Mtn 5963
Omak Mtn 5749
Van Brunt Mtn 5169
Armstrong Mtn 4587
Whitmore Mtn 3949
Strawberry Mtn 5855
Bald Knob 3656
Johnny George Mtn 4090
Miller Mtn 3115
Boundary Butte
Spokane Mtn 3870
Lilienthal Mtn 3568
Cayuse Mtn 2730
Round Mtn 2835
Blue Mtn 4203
White Mtn 6921
Seventeenmile Mtn
Swan Butte 3965
Cedar Ridge
King Mtn
Jacknife Mtn 5057
Bulldog Mtn
Profanity Peak
Togo Mtn 6148
Boundary Mtn
Mineral Mtn 4555
Horns Mtn 5004
Echo Peak 3099
Sneed Mtn 4995
Tunk Mtn 6054
Mt Annie 6052
Barker Mtn 3958
Burge Mtn 4353
Mt Bonaparte 7258
Mt Hull 4617
Palmer Mtn 4245
Bullfrog Mtn 4316
Cave Mtn 2892
Salt Hill 2936
Ragged Butte 2408
Oregon City Ridge
Onion Ridge
Rainy Ridge
Gold Mountain Ridge
Whitestone Ridge
Huckleberry Range
Huckleberry Mountains
Selkirk
Kelly Hill
Thompson Ridge
Aeneas Valley
Chief Joseph Dam
Grand Coulee Dam
South Dam
Long Lake Dam
Pinto Ridge
Columbia
Guide Meridian


Map 16
1974
DOUGLAS-FIR TUSSOCK MOTH
CONTROL PROJECT
ST. JOE UNIT
LEGEND
Control Areas
Pilot Project
Scale 0 1 2 3 4 Miles
Plummer Butte 4145
St Maries (2216)
Mowry
Benewah Cr
Moctileme Cr
Benewah
BENEWAH
Hangman
Liberty Butte
Tensed (2557)
De Smet
4949 Moses Mtn
John
Cr
Sanders
West Dennis 4808
4745 Tyson Peak
Charlie Cr
Nakarna Mtn
Mission Mtn 4324
Mineral Mtn
Meadow Cr
Bald Mtn 5334
Flynn Butte 3604
N Fk
Deep Cr
Gold Hill 4661
River
Beals Butte
W Fk
Onaway
WASHINGTON
IDAHO
Potlatch (2519)
Princeton
Palouse
Harvard
Hatter Cr
Ball Butte
8TH
MERIDIAN
GUIDE
1ST
Viola
Palouse Range
4983 Moscow Mtn
Stanford
Vassar
E Fk
Avon
MONTANA
Deary (2960)
Helmer
LATAH
Paradise Cr
Creek
MOSCOW
Howell
Troy


Map 17
1974
DOUGLAS-FIR TUSSOCK MOTH
CONTROL PROJECT
SAWTOOTH UNIT
LEGEND
Control Areas
Scale 0 .2 .4 .6 .8 1.0 Miles
SAWTOOTH NATIONAL FOREST
SOLDIER
FAIRFIELD
(BOISE 100 miles)
Spring Creek
Elk Creek
Minnehaha Creek
Blowout Creek
Cookslow Creek
Mill Canyon
Deer Creek
Chicken Creek
Big Deer Creek
Little Deer Creek
Sampson Creek
Wardrop
Soldier Creek
Powell Creek
Edwards Gulch
McCan Gulch

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